JANUARY-FEBRUARY 1961

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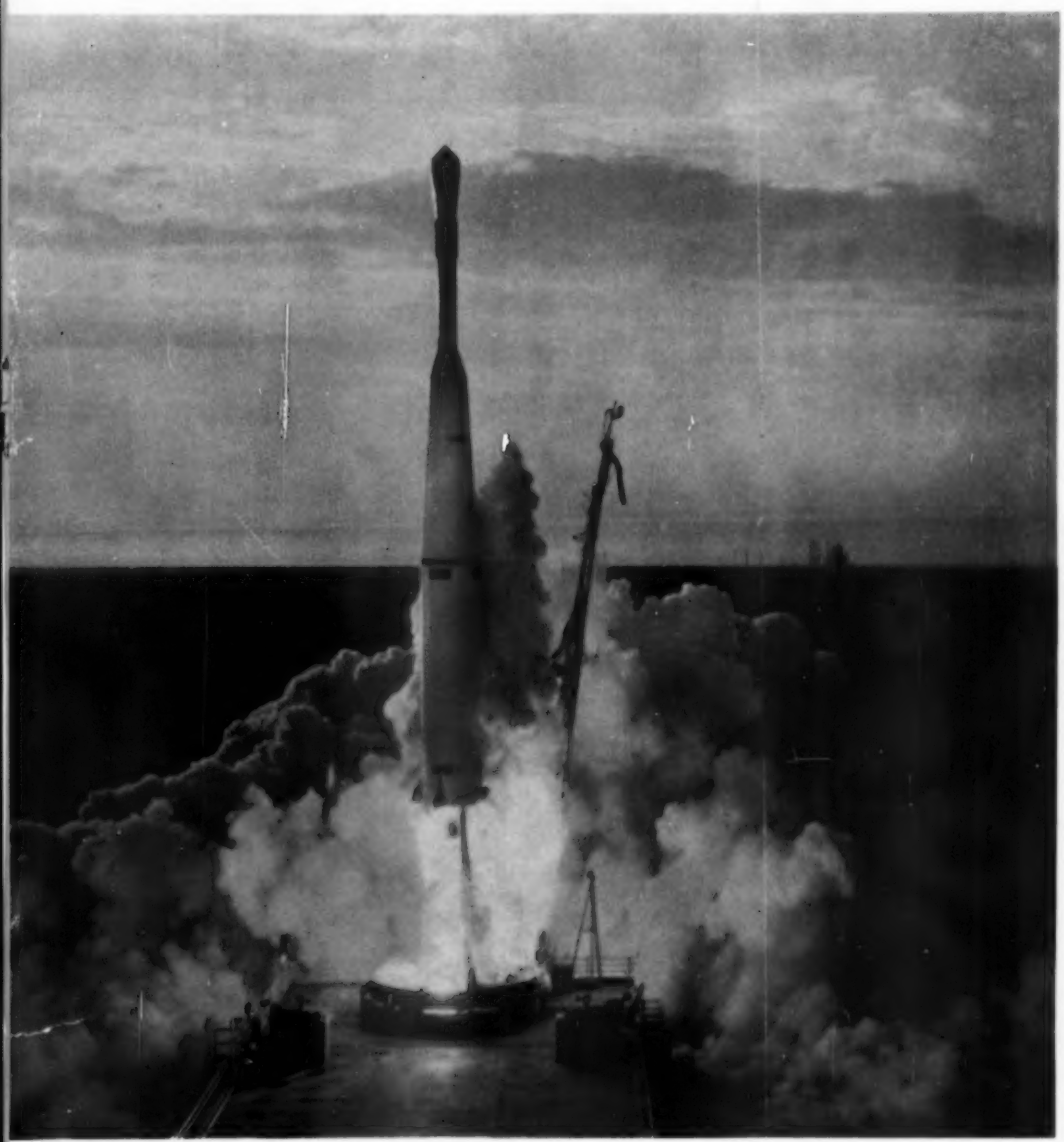
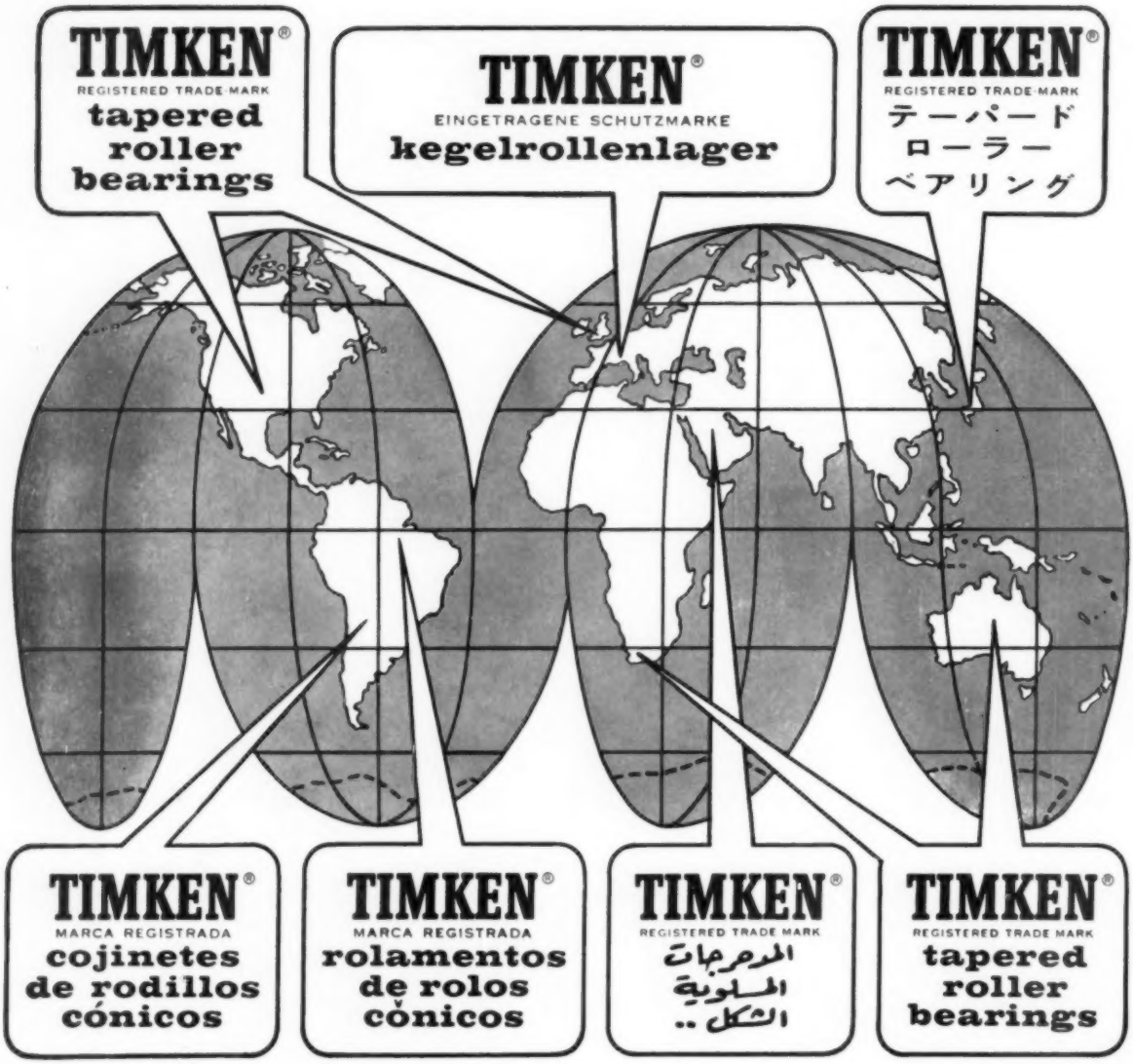


Tiros takes off

In this issue: James Burnham • Mark S. Watson • Rear Adm. J. P. Monroe • Neil H. McElroy
Dr. H. G. Stever • Jac Weller • W. T. Adams • Col. C. R. Tosti • M. H. Weik • Dr. H. Q. North



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Forty-one Years of Leadership in American Armament Preparedness

VOL. XLV JANUARY-FEBRUARY 1961 NO. 244

The Cover.—The Tiros meteorological satellite, shown leaving the launching pad, carries two television cameras to photograph cloud cover around the world as an aid to long-range weather forecasting.

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ARMAMENT TECHNOLOGY

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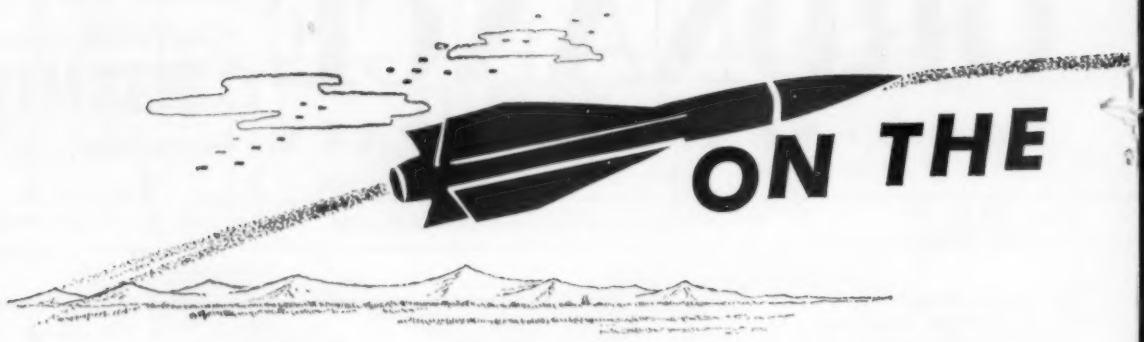


THE CONTENTS OF THIS ISSUE IN BRIEF

Sticks, Stones, and Atoms (p. 484) . . . . While the United States with its nuclear armament may be the most powerfully armed nation on earth it has not been able thus far to stop the march of Communism which has taken over country after country by the use of mobs incited by trained agitators and armed for the most part only with primitive weapons. "How many men and women do we have in training today to exploit mobs and street riots to our political advantage?" asks author James Burnham.

New Trend in Weapons (p. 488) . . . . At long last there is a noticeable swing away from almost total reliance on massive retaliation and toward ground force armament that emphasizes increased mobility and greater firepower. Mark S. Watson, noted military correspondent, here enumerates and describes this new ordnance equipment.

Our Missiles Are Mighty (p. 493) . . . . How can Americans say that the Soviets surpass us in missile power when we have effective guided weapons in every category and nearly twenty orbiting satellites to the Reds' two? Rear Adm. J. P. Monroe says that the United States has the greatest military capability the world has ever seen but that we do not intend to buy missiles we don't need.

Defense Must Be Adequate (p. 497) . . . . A former Secretary of Defense discusses the need for balance between our own physical resources and the requirements of our allies. Neil H. McElroy offers a thoughtful 3-point program to provide adequate deterrent strength, adequate foreign assistance, and adequate moral fiber to win the long fight against Communism.

Our Future in Space (p. 501) . . . . Among the many challenges of the new age upon which we are entering is the conversion of our space-oriented industries from the old production-based-profit type to the new engineering-based-profit type since engineering, rather than mass production, marks the manufacture of our new missiles and space vehicles. "Astronautics," says H. Guyford Stever of M.I.T., "has become big business."

Spanish Infantry Weapons (p. 503) . . . . "If we had to fight another Korea we probably would be aided by more soldiers from Spain than from any

other nation," writes Jac Weller, noted small-arms expert. Equipped with the excellent CETME rifle and backed up by effective supporting weapons, the Spanish infantryman is tough, well trained, and confident that he is more than a match for any would-be Communist aggressor.

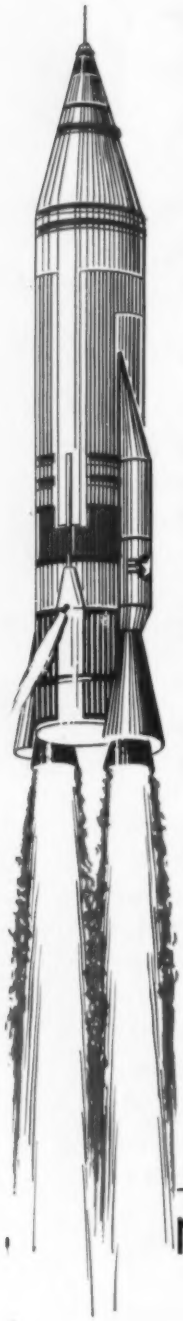
Guns for the Navy (p. 508) . . . . A real sailor who learned his trade before the mast, John A. Dahlgren worked his way up from midshipman to rear admiral and came to be called the father of American naval ordnance. Author W. T. Adams relates how Dahlgren's invention of the boat howitzer and the large shipboard cannon affected the art of naval warfare. No. 4 in the Civil War Ordnance series.

The Modern Minuteman (p. 567) . . . . Still in the testing stage, our newest ICBM will be a highly mobile weapon, ready for action from solid sites or constantly moving railroad cars, says Col. Carlo R. Tosti, Deputy Chief, Ballistic Missiles Branch, U. S. Air Force. In readable style, Colonel Tosti gives the facts about America's first solid-propellant, 6,300-mile missile.

The ENIAC Story (p. 571) . . . . The world's first electronic numerical integrator and computer was developed by the Ordnance Department of the Army during World War II to compute ballistic firing and bombing tables. Martin H. Weik of the Ballistic Research Laboratories at Aberdeen Proving Ground tells the exciting story of the early struggles and final triumph of this revolutionary device that gave birth to a whole new and important American industry.

Small but Reliable (p. 576) . . . . The development of transistors and other semiconductor devices has made possible new types of circuits with resulting miniaturization of equipment and—surprisingly enough—greatly increased reliability and maintainability. Present progress in this field is so rapid, says Dr. Harper Q. North, that it is impossible to predict future trends with certainty.

Materials in Space (p. 578) . . . . Ralph A. Happe of the Jet Propulsion Laboratory here describes the problems that will have to be solved in predicting the performance of metals and compounds in space operations. He cites the Ranger vehicle, which is scheduled to land an instrument package on the moon, as a case in point to show how new environments will demand new materials.



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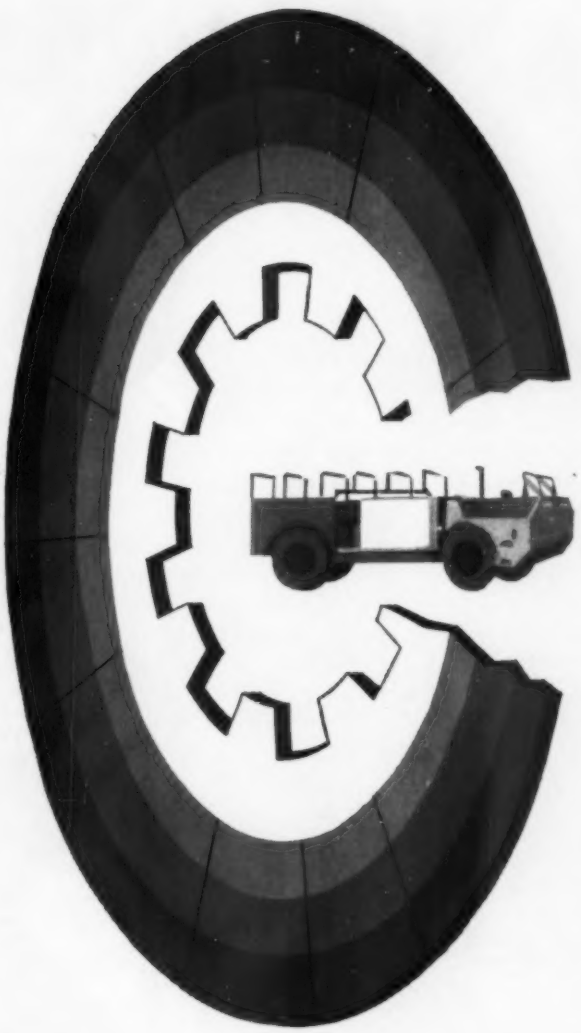

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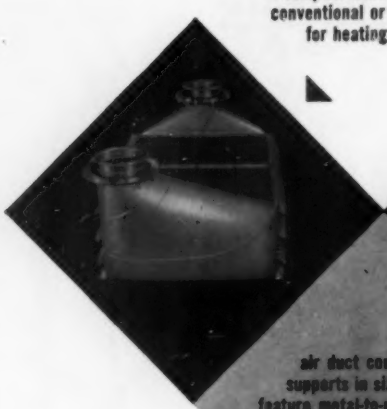

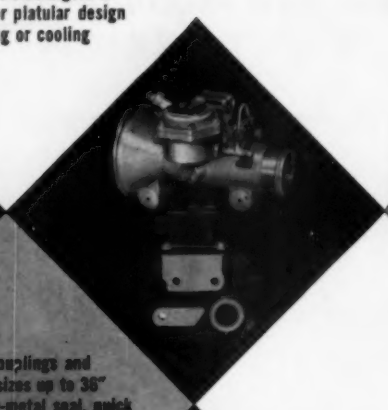

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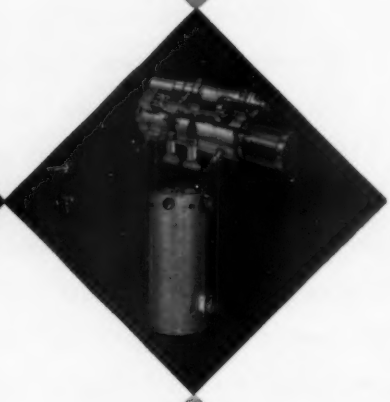

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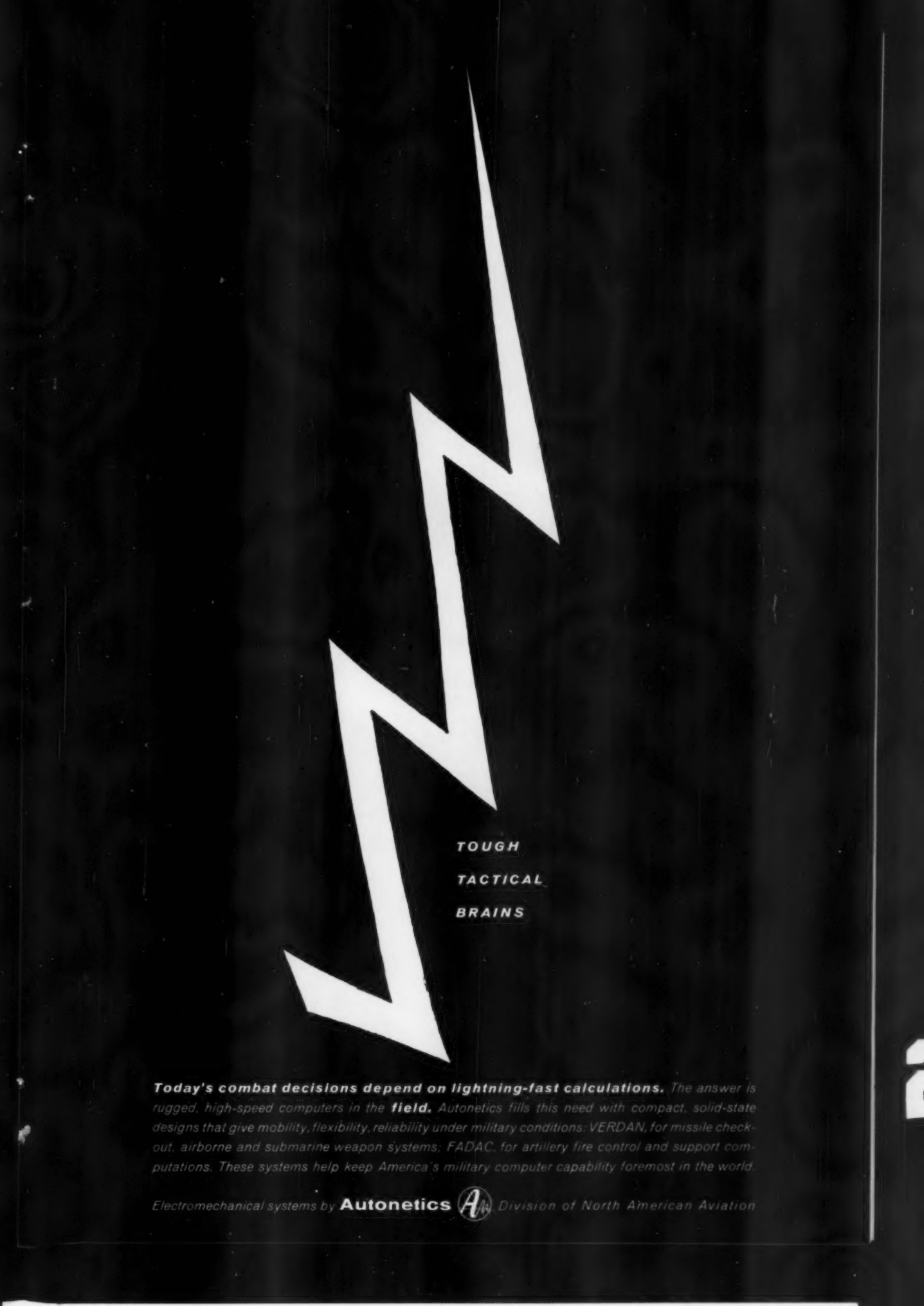

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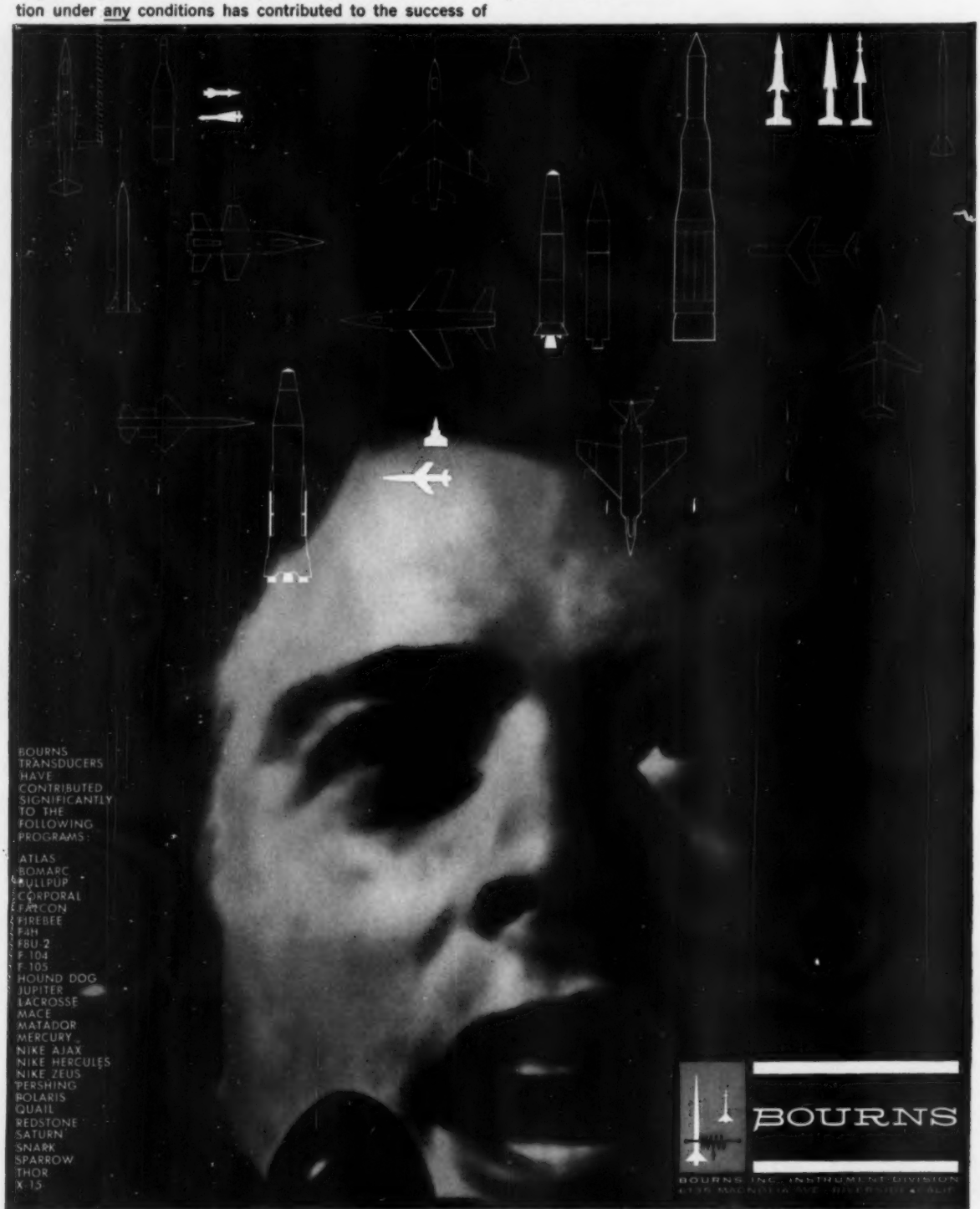

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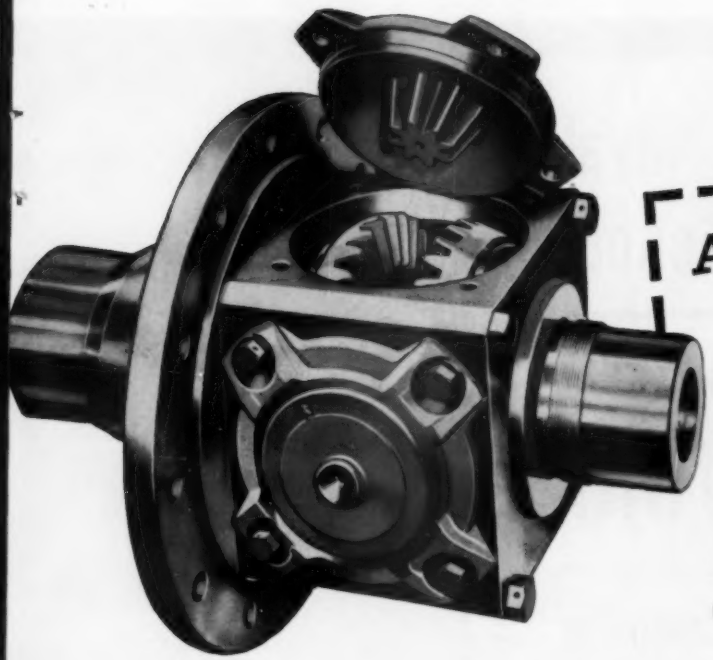

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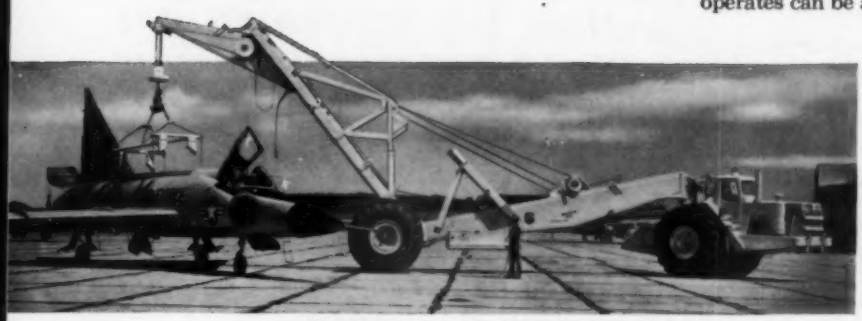

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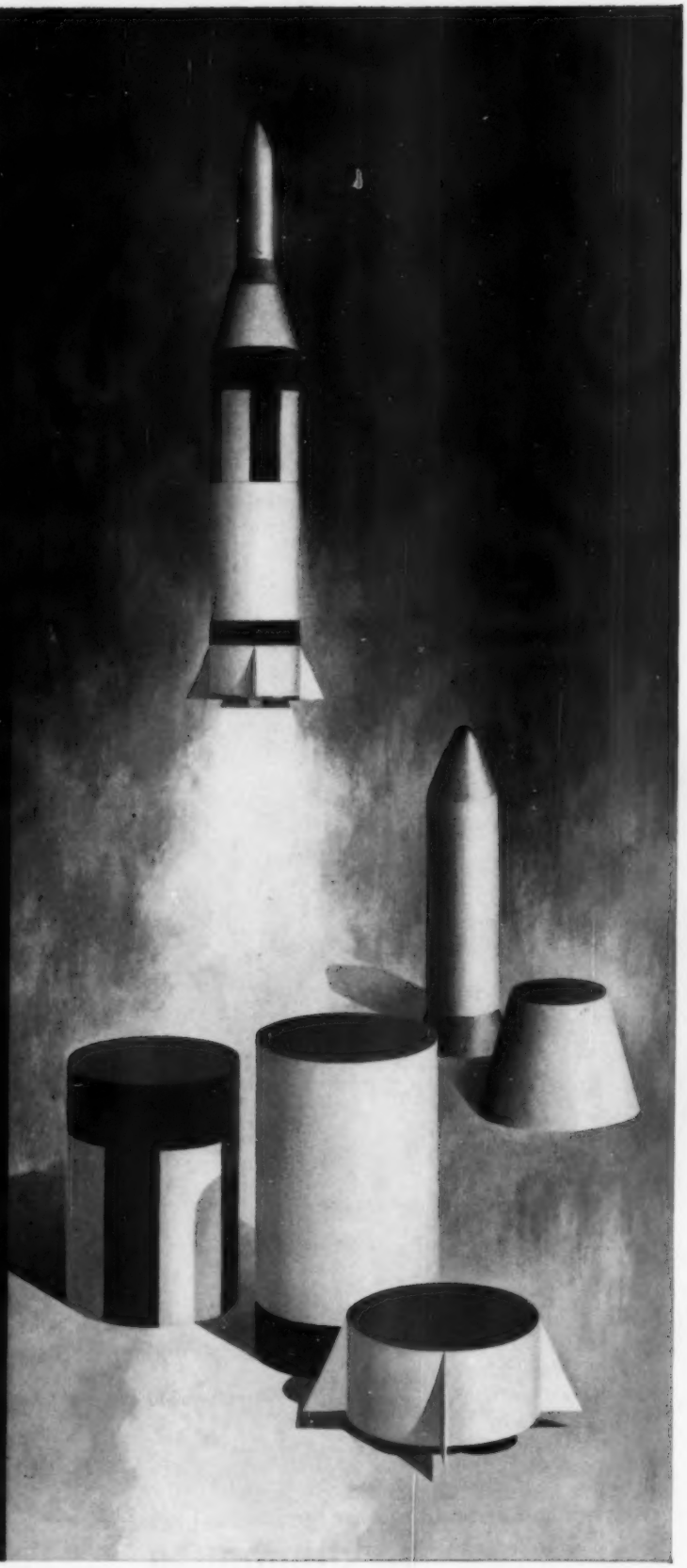

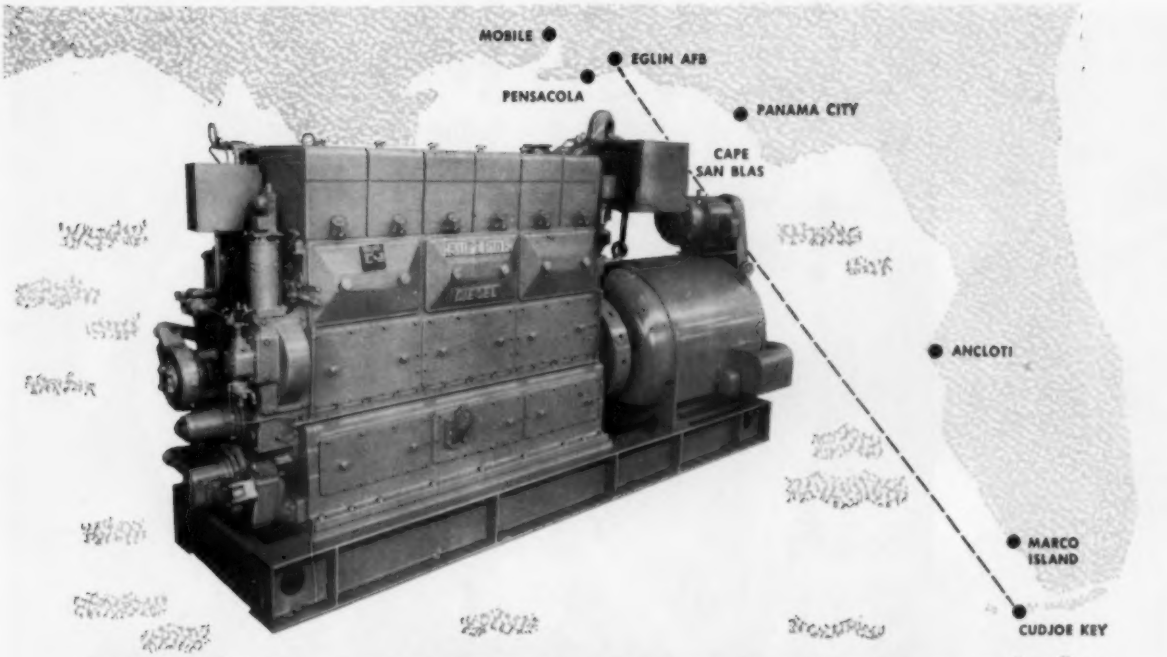

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. . . provides effectiveness for new system of mobile defense against multiple airborne targets

The program: MAULER, U.S. Army's newest automatic-firing air defense system, involving missile-firing vehicles transported by air and parachuted into battle areas. **Basic Burroughs contribution:** design and production of the miniaturized electronic computer systems which will provide radar data processing and computation for MAULER. Among special design features will be the Burroughs Logi-Mod packaging technique, to protect sensitive computer components from shock during air transport and parachute drop. **Behind the news:** Still another vote of confidence in Burroughs Corporation's Computence—total competence in computation—from basic research through production and field service to system management. Confidence in Burroughs performance, already proved in such vital programs as ATLAS, SAGE and ALRI.

Burroughs—TM

Mauler is being developed by Convair-Pomona, Convair Division of General Dynamics, for ARGMA, an element of the Army Ordnance Missile Command.

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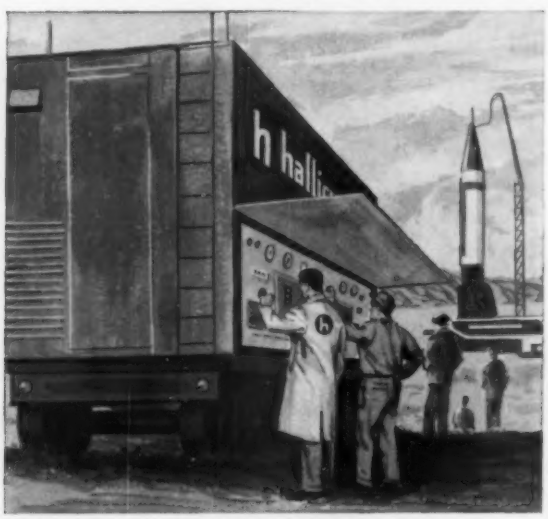
"NEW DIMENSIONS / in computation for military systems"

Every breakthrough in military electronic equipment design creates new, complex and urgent problems in installation, modification, testing, maintenance and personnel training. Hallicrafters radical new "Blue Streak" project—utilizing quick-reaction techniques—*offers experienced Hallicrafters support teams to assist key military personnel . . .* pinpoints problems in advance . . . solves them on the spot with new levels of speed and economy.

from Hallicrafters' "quick-reaction" experience...



TEAMWORK IN MAINTENANCE: Hallicrafters mobile test vans and in-house repair of black boxes sets new standards in speed and reliability.

Looking for a challenging new opportunity?
For this expanding program, we have openings for qualified aeronautical electronic equipment systems and installation engineers. For full details in confidence, contact William F. Frankart, Director of Engineering.

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TEAMWORK IN PLANNING: Hallicrafters "BLUE STREAK" Teams provide electronic industry technology in support of military programming groups for SAC aircraft at OCAMA and other materiel commands.

TEAMWORK IN MODIFICATION: Modernization of RF transmission systems completed in 30% less time through "BLUE STREAK" team assistance to base maintenance groups.

TEAMWORK IN INSTALLATION: Advanced ECM equipments are installed by "BLUE STREAK"-SAC teams with a minimum of down time. Maintenance and operational training is speeded up, too.

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For further information on Hallicrafters facilities and experience in military electronics research, development and production, please write to: THE HALLICRAFTERS CO., MILITARY ELECTRONICS DIVISION, CHICAGO 24, ILLINOIS.

Ferro-magnetic domain structure of thin film studied under electron microscope.

Experimental memory array produced by deposition of evaporated metal.

Seeking the enormous potential in a faint trace of metal...

Inside vacuum chambers in Remington Rand Univac's laboratories, metal alloys melted at intense heats evaporate and then condense to form deposited films measuring 300 to 500 atoms in thickness.

Scientists at Univac searchingly study these microscopic traces of metal.

In them they see exciting possibilities for computers of the future...computers in which deposited thin film elements will supersede current memory cores and other logical elements. The potential advantages: Phenomenally faster switching time, more rapid access to and processing of data, reduced power consumption and smaller equipment.

Conceivably, memories produced in this way will have a cycle time of one-twentieth of a micro-second, and a 1,000 word memory array will occupy only a few cubic inches.

This is one example of dynamic research programs which are continually adding to Remington Rand Univac's capabilities in both commercial and military fields.

Military Dept., Remington Rand Univac, Division of Sperry Rand Corporation, Univac Park, St. Paul 16, Minn.

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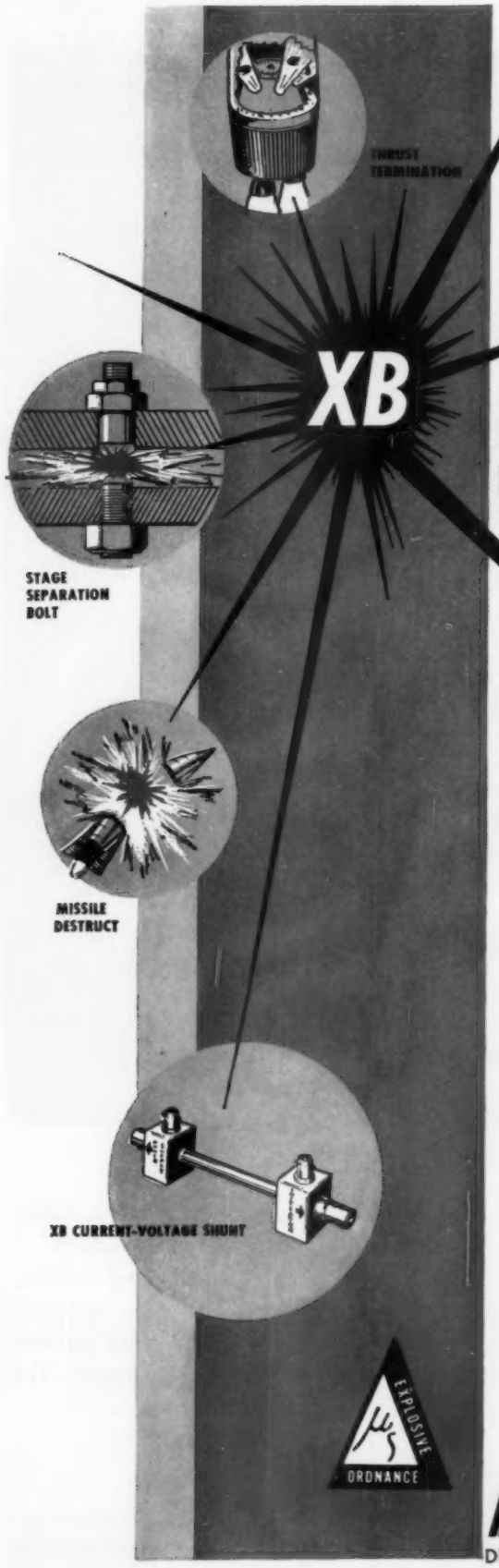

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by McCormick Selph Associates offer:

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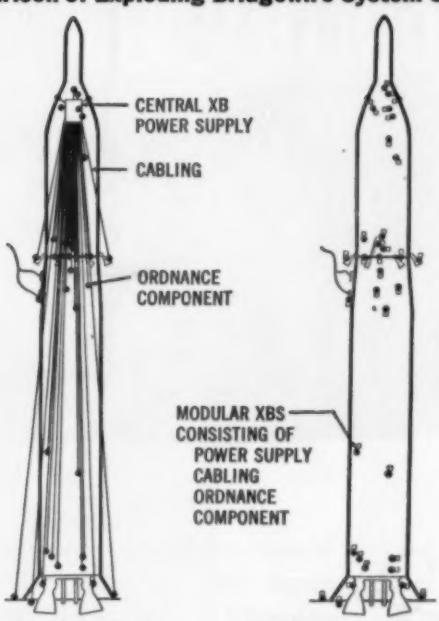
3. Greater Design Flexibility

Comparison of Exploding Bridgewire System Concepts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COMPLEX CENTRAL XB POWER SUPPLY SYSTEM

XBS MODULAR SYSTEM CONCEPT BY McCORMICK SELPH ASSOCIATES

*McCORMICK SELPH ASSOCIATES, INC. and the Industrial Products Division of **ITT** combine their ordnance and power capabilities to provide the best in EXPLODING BRIDGEWIRE SYSTEMS

Direct Inquiries to Product Division,

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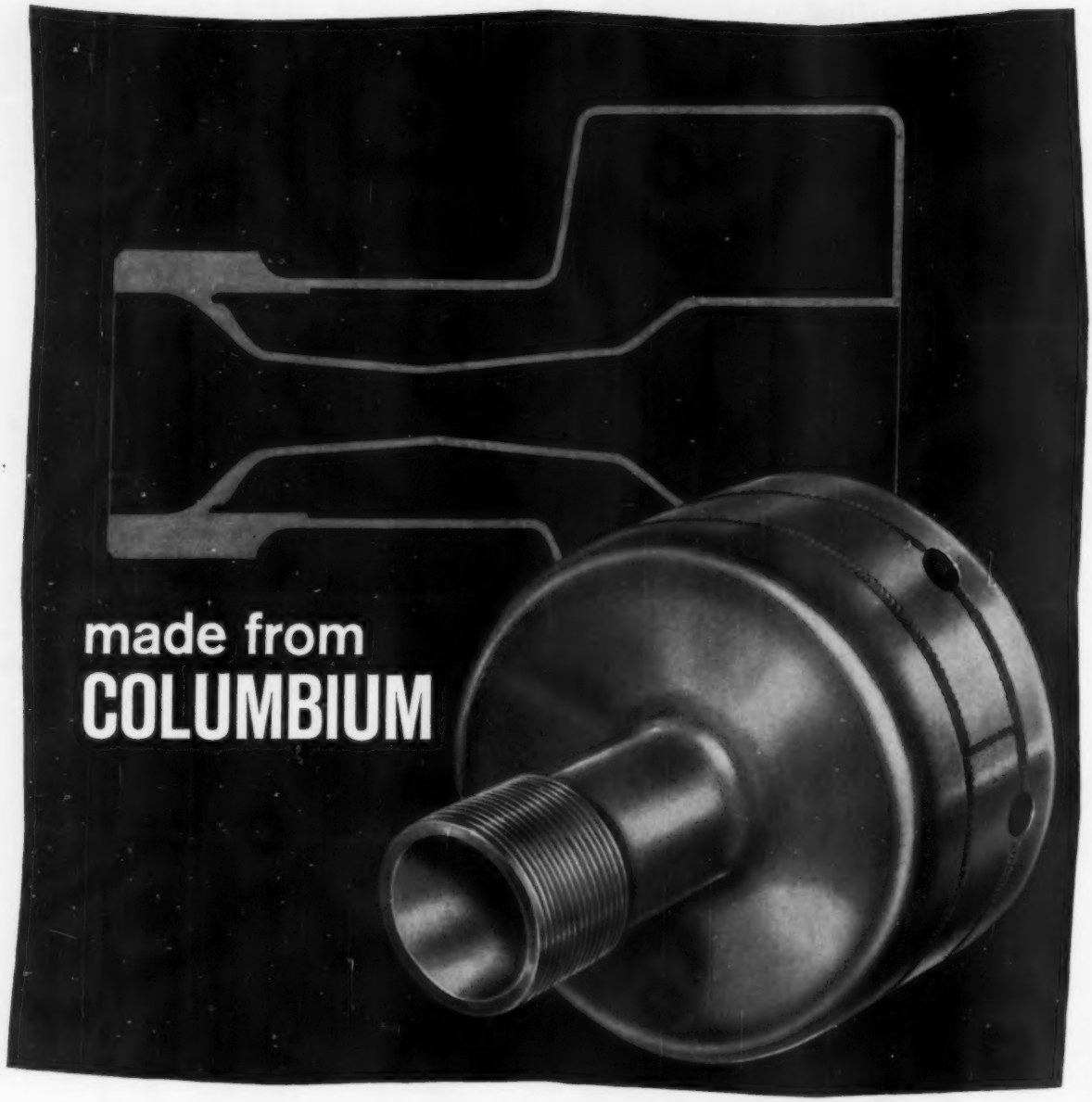

Mere conventional knowledge about metals does not account for the successful welding, machining and spinning that this structure has undergone. The Budd Company has solved many of the critical problems of fabricating a reliable structure from columbium—as well as from other promising new metals such as zirconium, hafnium, beryllium, tantalum and molybdenum.

A pioneer for years in forming and welding, we are prepared to fabricate these materials today. Let us know if you want more information. Product Development Department, The Budd Company, Philadelphia 32, Pa.

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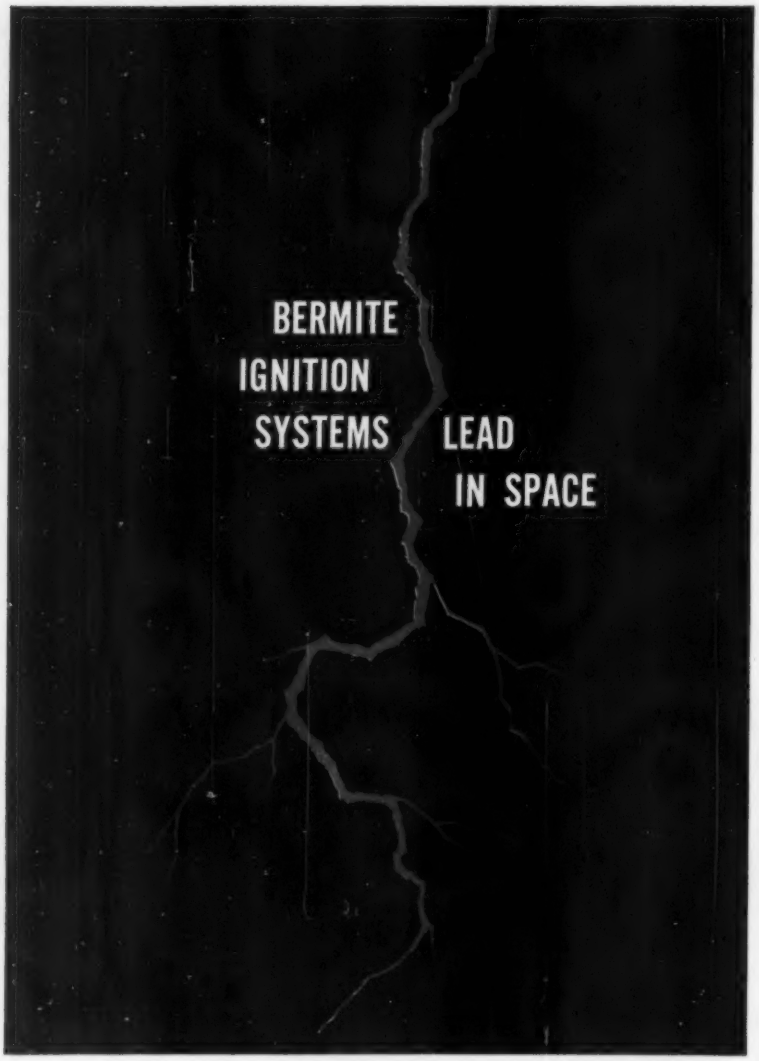

Bermite's ignition systems are safe, reliable and permit precise controls which make possible the optimum performance of propulsive units. Designed, developed and manufactured for various missile systems, Bermite igniters have demonstrated their superiority through extensive qualification tests and in service performance. Actual performance in the missile industry has proved Bermite's leadership in the ignition field.

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ATOMIC ENERGY

Arctic Power Plant

A portable nuclear power plant has started generating electricity for 105 civilian scientists and military personnel at the Army's undersnow installation at Camp Century, Greenland, located about 800 miles from the North Pole. The plant also is producing steam for melting subsurface snow for the camp's water supply.

The camp has thirty prefabricated buildings which will provide housing, laboratories, and other necessary units to enable men to work and live comfortably in one of the earth's most forbidding climates. During the long winter night, which lasts from October to February, surface temperatures are expected to reach 70 degrees below zero and winds will blow at velocities of 125 miles an hour or more.

The camp is entirely below the surface, except for ventilation shafts, entrances, and exits.

The 2,000-kw. semiportable, prepackaged nuclear power plant, which was manufactured by Alco Products, Inc., Schenectady, N. Y., is air-transportable.

Radiation Detector

The Nation's first experimental ground-based detector station for studying one of the methods which might be used to detect nuclear detonations in near space has been developed by the Los Alamos Scientific Laboratory, which is operated for the AEC by the University of California.

This test operation program is part of the United States' research and development program to develop and improve means of detecting nuclear explosions in space and underground. Known as project Vela, this program is being conducted by the Advanced Research Projects Agency of the Department of Defense in cooperation with the AEC, the National Aeronautics and Space Administration, the Defense Atomic Support Agency, and other Government agencies.

This Los Alamos station is designed to investigate an atmospheric fluorescence detection technique originated by the Los Alamos Laboratory. This technique has been proposed for inclusion in the world-wide network of ground stations for detection of nuclear explosions in space which has been discussed at Geneva.

The fluorescence detector uses a narrow-band filter and an optical detector mounted behind a wide-angle lens to de-

tect visible fluorescence in the upper atmosphere such as might be created by radiation from a nuclear explosion.

Plutonium Recycle Reactor

The plutonium recycle test reactor at the Atomic Energy Commission's Hanford plant near Richland, Wash., achieved initial criticality (a controlled, self-sustained nuclear chain reaction) on November 21, 1960.

During the start-up test period, various patterns of fuel loadings will be inserted into the reactor core and mechanical checkout tests will be completed. Reactor power level will be increased gradually until the design power of 70,000 kilowatts of heat is reached.

The plutonium recycle test reactor is a heavy-water-moderated and -cooled pressure tube-type reactor. It will be used to test plutonium-bearing fuel elements and to develop technology and techniques for using recycled plutonium as fuel in civilian power reactors. Fuel elements for the reactor contain plutonium, a product of the irradiation of uranium, as the enrichment material rather than uranium 235 heretofore used exclusively in civilian power reactors. Since the function of the plutonium recycle test reactor is to accumulate scientific knowledge, no electric generation facilities are included in its design.

Radioisotope Manual

The AEC has published the first full-fledged laboratory manual on radioisotopes for use in college and university chemistry courses.

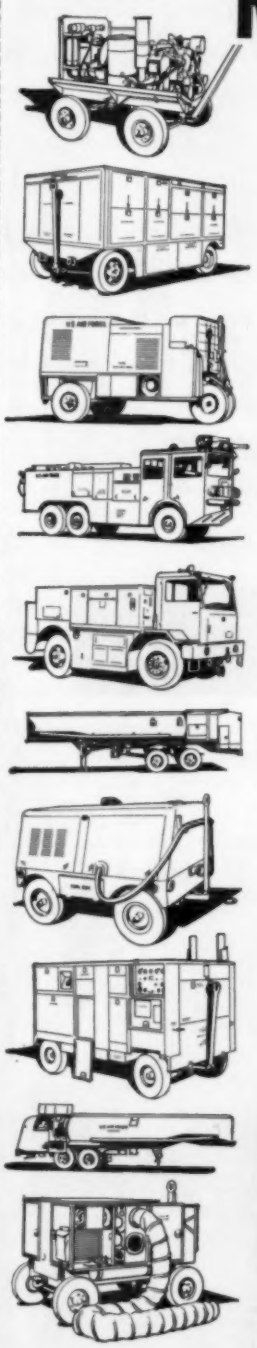
The manual, entitled "Radioisotope Experiments for the Chemistry Curriculum" (TID 6374), was prepared, under contract, for the Commission's Office of Isotopes Development. It is designed to introduce the chemistry student to radioisotope techniques and to demonstrate their potential contribution to his future work. Preparation of the manual reflects the growing routine use of radioisotopes as a valuable tool in chemistry and biology laboratories, hospitals, and many scientific research centers.

The experiments have been developed and tested for a maximum laboratory group of thirty students. Since many academic institutions find it difficult to set up an entirely new course in already crowded schedules, most of the experiments may be easily worked into established courses.

All the experiments may be performed without special AEC license, with a package of radiocompounds stock-ordered from licensed suppliers. Only basic nuclear detection equipment already available at reasonable cost from any commercial supplier is necessary to conduct any of the experiments.

A sample copy of the manual, together

CONTINENTAL PACKETTE POWER
USE-PROVED
Round the Globe



Ground support equipment built around Packette power is proving itself today on defense installations all over the free world.

Developed by Continental Motors, with the famous Continental air-cooled aircraft engines as their basis, these five Military Standard models [Mil. E-26248 (USAF)] range from 30 to 250 hp, combine compactness and light weight with ease of servicing and upkeep, and operate at any temperature from equatorial heat to polar cold. Of special interest and importance, as simplifying maintenance in the field, is the wide interchangeability of parts among the several Packettes, and between them and the models in the Continental aircraft engine line.

They're use-proved NOW in air conditioners, compressors, crash trucks, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose tugs and other applications. Experience is proving: IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER ENGINE WILL DO THE JOB SO WELL.

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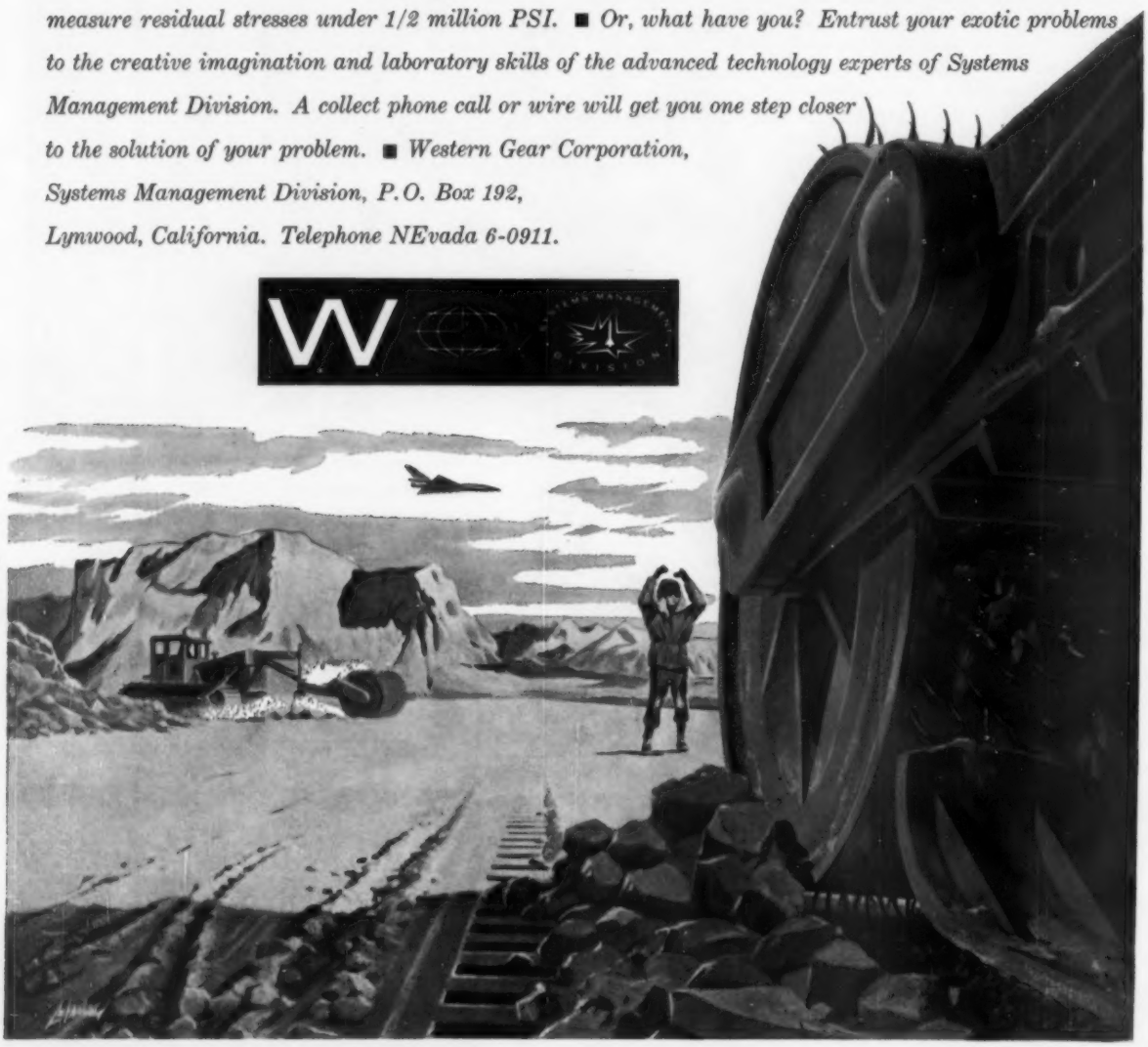

with a set of instructor notes, is available to colleges and universities upon request to the Director, Office of Isotopes Development, U.S. Atomic Energy Commission, Washington 25, D. C.

New Drawing Distributor

As a part of its policy of discontinuing certain services when private industry shows a capability to perform that operation at a reasonable cost, the Atomic Energy Commission has contracted with a private firm to serve as the Commission's distribution center for engineering drawings required by Government and the nuclear industry.

Under contract with the Commission, the Cooper-Trent Blueprint and Microfilm Corporation, Arlington, Va., will fill requests of the Commission and other Government agency contractors, industrial concerns, and the general public for full-size blue-line prints of engineering materials (drawings, specifications, photographs, and bills of materials).

Previously this service has been done by the Commission's Office of Technical Information Extension at Oak Ridge. The prints will be sold at an established price of 17 cents per square foot with substantial discounts for quantity orders. The contractor expects to provide 24-hour service.

Direct Cycle Reactor

The Pacific Gas & Electric Company, of San Francisco, Calif., will construct a nuclear reactor at its Humboldt Bay power plant near Eureka, Calif.

The facility is to be a direct-cycle, natural internal circulation boiling-water reactor with a gross electrical output of 50,000 to 60,000 electrical kilowatts. The reactor is to serve as a third unit of the P. G. & E.'s Humboldt Bay plant which now comprises two conventional steam-electric generating plants with a capacity of 100,000 kilowatts.

A novel scheme of pressure suppression containment has been proposed for the Humboldt Bay unit. The basic components of the system will consist of a pressure-tight, carbon-steel vessel, called the dry well, which will enclose the reactor vessel and associated piping up to the first valve in each line and the control-rod drives.

The dry well will be surrounded by another pressure container constructed of reenforced concrete and lined with thin steel plate. This container, known as the suppression chamber, will be partially filled with water, which is referred to as the suppression pool.

The dry well and suppression pool are designed to function in the event of any failure occurring to reactor pressure vessel fittings or primary system piping up to the first valve.

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Light as aluminum, structurally strong, exceptional chemical properties and high insulation resistance —this tubing is superior to many other materials.

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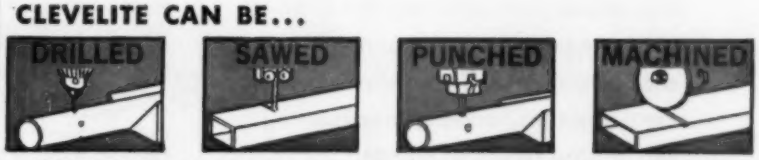

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ANSWERS TO YOUR QUESTIONS

What is Fullstop? A highly slip resistant, water base floor finish of acrylic polymer type. *How does it differ from water waxes?* Waxless, it contains synthetic resins and plasticizers dispersed in water. Creates harder finish than wax; affords greater protection. *Where can it be used?* On properly sealed wood, also asphalt, vinyl, linoleum, rubber, terrazzo and ceramic tile. *Easily applied?* Excellent levelling makes it easier than any wax. *How about additional coats? Patching?* First coat must dry before applying additional coats. Repair heavy traffic areas by patching. *Waterproof?* Water base finishes are not completely waterproof but FULLSTOP rates with best. *Easy removal?* Strips as easily as ordinary wax, but stripping required less frequently — less discoloration.

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Megawatts for NIKE ZEUS...

With a booster of over 450,000 pounds of thrust, NIKE ZEUS will need still another form of power to fulfill its anti-missile assignment. This other power is in millions of watts – energy for the system's extended range target tracking and discrimination radar transmitters.

Developed for the Army by Sperry out of its long experience in high power radars, and employing giant-wattage Sperry klystron tubes, the target tracking transmitters will permit greater-than-ever capability for radar tracking of "hostile" targets. The discrimination radar is designed to classify targets according to the nature of the threat.

NIKE ZEUS – the nation's only anti-missile missile system now in the advanced development stage – is undergoing R&D and pre-production programming under the Army Rocket and Guided Missile Agency (ARGMA) cognizance, with Western Electric as prime contractor and Bell Laboratories responsible for the overall system. It is the only missile system now in development for intercepting ICBM's . . . to defend our cities and defense sites.

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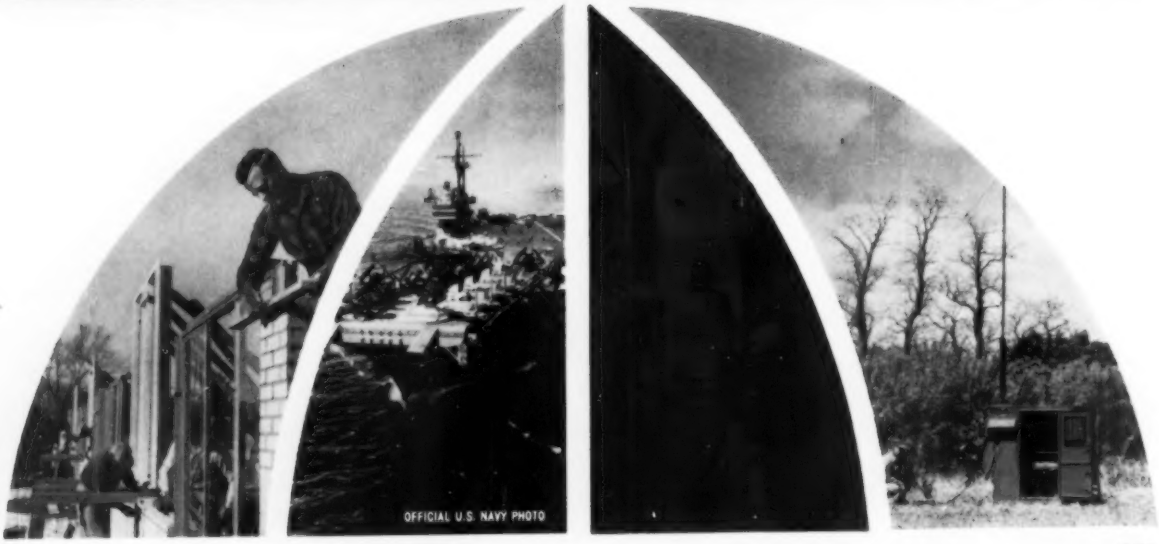

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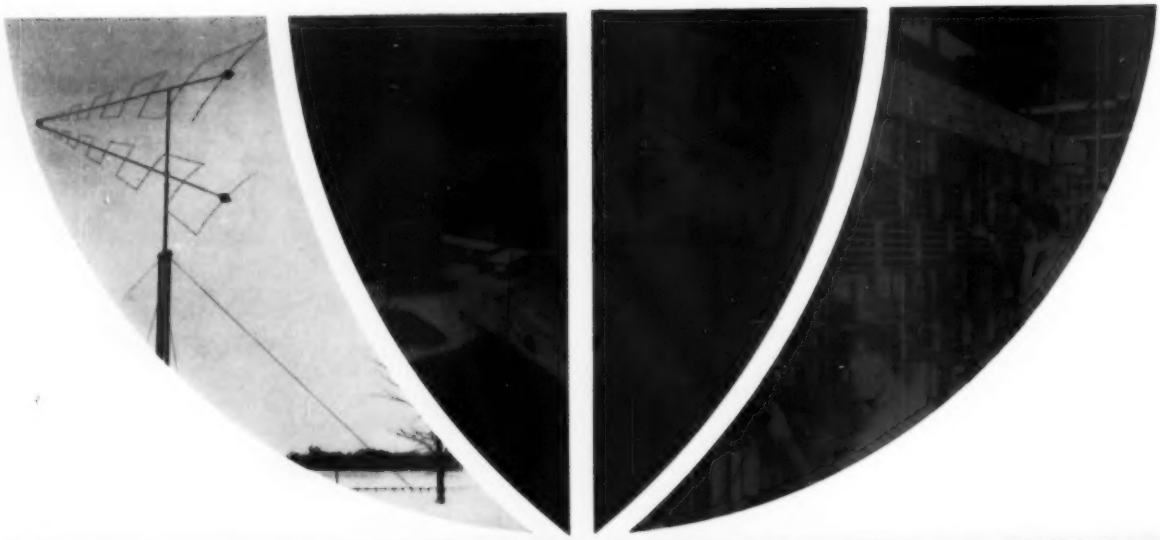

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Alpha Corporation in its systems engineering and management role is playing a vital part in highly diversified communications, instrumentation and control systems for government and industry.

Pacific Missile Range instrumentation, communication and data handling systems serve the nation's largest missile range, stretching from Point Mugu westward, by way of islands and range ships.

Satellite and deep space probe air transportable tracking and communications systems for NASA, JPL and the Signal Corps have been engineered to handle a wide range of missions.

Naval Tactical Data System makes possible rapid transmittal and display of radar, fire control and similar types of data simultaneously between all elements of a naval task force deployed at sea.

Short Order system provides positive two-way voice contact needed to control all airborne elements of Strategic Air Command through any of four widely dispersed HF single sideband station complexes.

Air Transportable Communication Central allows Marine Corps command post to route teletypewriter, voice and telegraph communications between landlines and self-contained HF single sideband station with complete switching flexibility.

Project Echo passive satellite communication experiment successfully transmitted voice, teletypewriter and facsimile between Collins at Cedar Rapids and Alpha at Dallas in joint company-financed tests of feasibility of satellite relay communication.

Far East Tropospheric Scatter System provides multiple channels for voice, teletypewriter and data communication between Formosa and Okinawa, a 410-mile over-water link in the Armed Forces Pacific Scatter Network.

Asiatic Petroleum 500-mile communication system combines Tropospheric Scatter and Microwave to link Shell Oil's Venezuelan Headquarters at Caracas with its refinery at Cardon, and its western oil operations area.

Alpha CORPORATION

A SUBSIDIARY OF COLLINS RADIO COMPANY

SYSTEMS DESIGNERS, ENGINEERS, CONSTRUCTORS, WORLD-WIDE

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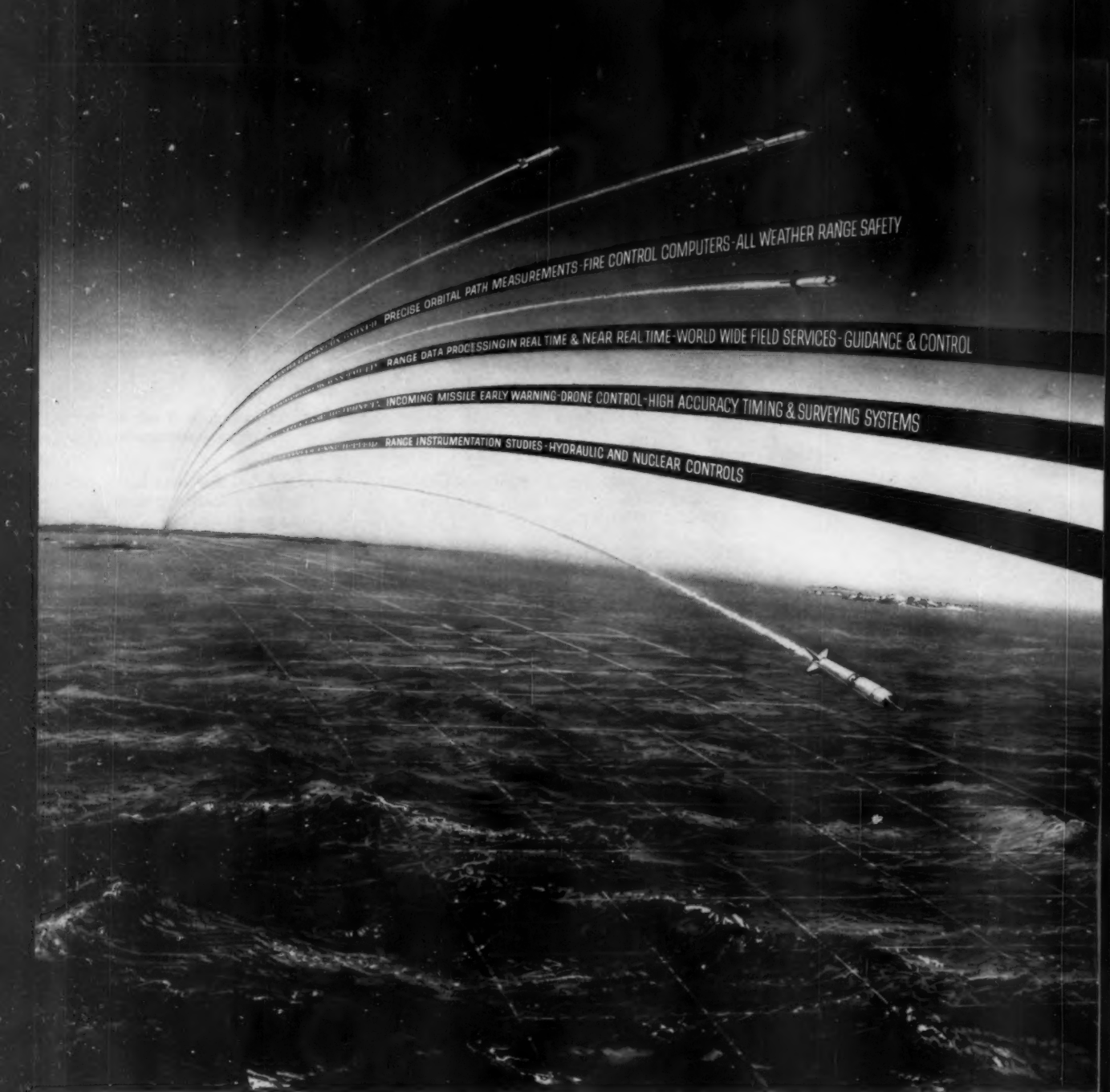
PRECISE ORBITAL PATH MEASUREMENTS-FIRE CONTROL COMPUTERS-ALL WEATHER RANGE SAFETY
RANGE DATA PROCESSINGIN REAL TIME & NEAR REAL TIME-WORLD WIDE FIELD SERVICES-GUIDANCE & CONTROL
INCOMING MISSILE EARLY WARNING-DRONE CONTROL-HIGH ACCURACY TIMING & SURVEYING SYSTEMS
RANGE INSTRUMENTATION STUDIES-HYDRAULIC AND NUCLEAR CONTROLS

THE MISSILE RANGE: Measure of Capability

The missile range today is a vast proving ground for advanced technologies. It symbolizes the "state of the art" in computation, physics, chemistry, metallurgy, propulsion, hydraulics, electronics, inertial guidance, communications and every other scientific field.

The most critical need of the missile range is to *know system performance exactly*. This calls for integrated standards of measurement and data handling, and therefore for entire systems and entire installations engineered to that objective.

To this problem Sperry Rand has a logical answer: *compatible instrumentation*. The scope of Sperry Rand capability, illustrated above, embraces the whole panorama of the space age. Compatible Instrumentation is the principle of precision in missile range measurement, and a plan of action for applying this principle to projects now developing.

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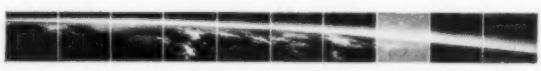

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GEN. LAURENCE S. KUTER

Commander, North American Air Defense Command

Deterrent by Defense

The continuing vital role of the North American Air Defense Command

8

THE North American Air Defense Command (NORAD) has created a defense against a possible attack by hostile aircraft on this continent sufficiently strong to deter such an attack. While continuing this capability, it is earnestly seeking the complete answer to long-range ballistic missile defense, and an adequate defense against such missiles will indeed constitute a most important deterrent to nuclear missile attacks.

The creation of NORAD has demonstrated the kind of international, national, interservice, and service effort in planning and operation that the United States and our Canadian allies can accomplish.

The North American Air Defense Command with headquarters in Colorado Springs, Colo., is the first 2-country, all-service type of military command ever to operate within the boundaries of the North American Continent. It is the first peacetime organization with cooperative operational defense planning involving a situation wherein the governments of Canada and the United States place military forces at the disposal of a single joint commander. Additionally, within the United States, it is the first time elements of the three services have operated under one unified commander.

NORAD's Commander in Chief, U. S. Air Force General Laurence S. Kuter, is responsible to both the U. S. Joint Chiefs of Staff and the Canadian Chiefs of Staff Committee. His deputy, and the man solely responsible for air defense in the absence of General Kuter from his headquarters, is Royal Canadian Air Force Air Marshal C. Roy Slemon.

General Kuter also commands the U. S. Continental Air Defense Command. It is staffed by U. S. personnel on the staff of NORAD as a dual-role function. Until January 1, 1959, the Commander in Chief of NORAD had only operational control of U. S. forces (as he still has of Canadian forces). This latter meant what the term implied: Control of the forces while they were operating on air-defense missions. The change to operational command of U. S. forces means that the Commander in Chief has greater authority over these forces, as provided by the U. S. Defense Reorganization Act.

DEFENDING North America is a 24-hour, 7-day-a-week job. NORAD's efforts are governed by the knowledge that an attack could come at any moment and that the first attack could seriously affect the outcome of the war.

We do not have and will not have a completely tight defense against aircraft and missiles. However, we do have in BMEWS, Dew Line, Midcontinent Line, Pinetree Line, Texas towers, and the Atlantic and Pacific barrier lines, early-warning detection and tracking capabilities that will give the Strategic Air Command time to perform its devastating mission and also assure the effective use of Air Force and Army air-defense combat units.

The future ability of NORAD to thwart missile attacks depends upon the early completion of antimissile weapon systems, and General Kuter's recommendation for early action on Nike Zeus production indicates his concern for our missile-defense capability. Whatever the situation, General Kuter and NORAD will continue their instant readiness to make the best use of all available weapons.

Laurence S. Kuter was appointed to West Point from Rockford, Ill., and was graduated in the Class of 1927. After two valuable years in the Field Artillery, he entered flight training and established an early reputation in both bombardment and pursuit flying.

After graduation from the Air Tactical School he was retained as an instructor. In 1939, Gen. George Marshall selected him as one of a small group of outstanding young officers for General Staff duty in the War Plans Division.

Lieutenant Colonel Kuter became assistant secretary of the War Department General Staff and was a major author of plans for reorganization of the War Department. He was promoted to brigadier general in February 1942 and was reassigned as Deputy Chief of Air Staff. After combat service in Europe and Africa he returned to the Air Staff in May 1943 and the following year was promoted to major general.

General Kuter served as an Air Force representative at combined Chiefs of Staff conferences in Quebec, Cairo, and London and represented General Arnold at the Yalta and Malta conferences.

After service in the Pacific and Korean areas he was promoted to lieutenant general as Deputy Chief of Staff for Personnel. Two years later he became Commander of the Air University, Maxwell Air Force Base, Ala., and in 1955 he was promoted to general and commanded the Far East Air Forces.

In the 1957 reorganization General Kuter was transferred to Hawaii as Commander in Chief, Pacific Air Forces, and in 1959 became Commander of the North American Air Defense Command.

Sticks, Stones, and Atoms

While the United States has been stockpiling nuclear armament the Communists have been taking over country after country by the use of well-directed mobs equipped with only the most primitive weapons

James Burnham

NOT long after the United Nations patchwork expeditionary force was rushed—or, perhaps better, sucked—into the Congolese maelstrom, a striking news photograph was widely printed in the American press. It showed a truckload of soldiers about to start off for the Léopoldville suburbs. The men were part of a crack, British-trained unit of the Ghana army.

As displayed in the picture, they were standing at attention in the truck, in two close, smartly drawn ranks. Suspended from the left arm of each soldier was a round shield, looking as if it had been snatched from a museum's medieval armor collection or from the prop room of a grand-opera company.

A friend of mine, an able and hard-working officer now at the Pentagon, noticed this picture and smiled. "The Sir Galahad weapon system! How's that for defensive armament in the nuclear age?" he asked sarcastically. He was much surprised when I commented: "It's not too bad, as a matter of fact. Better than most."

In these Ghanian shields, a light, strong aluminum alloy has replaced the wood, leather, brass, and iron of ancient bucklers. Their purpose is protection against the sticks, rocks, and stones thrown by rioting mobs. In the nuclear age, stones function as weapons a good deal oftener than nuclear bombs—and have won many more battles.

Mr. Burnham is a distinguished writer and lecturer in the fields of government and political science, and author of "The Coming Defeat of Communism," "Containment or Liberation?" "The Web of Subversion," and many other works.

On both sides of the Iron Curtain many strategists believe that a curious law applies to the quantum jumps in firepower that have marked the weapons development of the past two decades. Beyond a certain limit—already passed by H-bombs—the more powerful the weapons become the less chance there is that they will be used. The reason for this is that fewer and fewer occasions would be taken to justify their use.

This is true even if one side had a monopoly. You are not going to start throwing H-bombs around to halt a border skirmish in the Cameroons or to block a change of government in Paraguay. When both sides possess the superpowerful weapons, the appropriate occasions are reduced to the brink of zero.

Indeed, many analysts are convinced that the only event that would be taken by either side as a sufficient motive for launching the most powerful weapons would be an attack with such weapons by the *other* side. If this puzzling conclusion is true, then an all-out unlimited war can take place *only* through faulty intelligence or an accidental launching.

In practice there seems to be a still more paradoxical corollary to this law of the inverse relation between the power and use of modern weapons. The more powerful the new weapons that *exist*, the more primitive the weapons that are actually *used*. Castro conquered Cuba with small arms, mimeograph machines, and portable radio transmitters.

The rioting mobs of Tokyo, Seoul, and Ankara that overturned governments and forced the cancellation of the visit of the head of the most powerful nation in the world were armed with nothing more than their fists, the staves used to raise their placards, and paving bricks, plus a few knives and revolvers. In the Congo, we have gone back to clubs, rocks, blow guns, and magical spells.

IT is terribly hard for Americans to understand something so simple. In uniform and out, we have been dutifully trying to learn about grandiose "weapons systems" made up of infinitely complex aircraft, bases, carriers, nuclear devices, ballistic missiles, nuclear submarines, electronic computers, inertial navigators, and what not.

On a single system of this sort—for example, Polaris, Titan, Minuteman, or the B-52 complex—we are ready to

spend five, eight, or ten billions of dollars as well as immense quantities of manpower, effort, technical ingenuity, and scientific intelligence.

It is well and good and necessary that this should be. But at the same time we seem to have difficulty in focusing our attention, not to speak of our brains and dollars, on the weapons systems by which the struggle for the world is in fact being fought.

We should more frequently remind ourselves that only two nuclear devices —crude, relatively low-power types at that—have ever been used for combat purposes. In the fifteen years since that parenthetic employment there have been many victories and defeats vast in scope and lasting in consequences. Power over many nations, whole regions of the earth, hundreds of millions of human beings, has changed hands—all without benefit of direct nuclear leverage.

Those rioting mobs of Tokyo, Seoul, and Ankara needed no A- or H-bombs, or planes or tanks or even guns to topple governments. Gandhi and Nehru had no strategic air force to help them drive the British Raj out of the Indian subcontinent.

INDONESIA, Iraq, Cuba, Bolivia, Egypt, Guatemala, Vietnam, Cambodia, the Congo, the Rhodesias. . . . It is mostly sticks and stones, rifles and submachine guns—and the mobs of course: the mobs are a primary element of the weapons systems that have been deciding most battles and campaigns of the struggle for the world.

Words also, of course—the words of agitation and propaganda, zeroed in on minds—for in these battles of our age, unlike the old nursery rhyme, words as well as sticks and stones can break our bones.

From 1945 until some time after 1950 we possessed a monopoly in operative nuclear arms and thus overwhelming superiority in over-all firepower. But it is in those same years that our enemy made his greatest conquests since 1917, seizing eastern Europe, with 100 million inhabitants, and mainland China, with 600 million.

The weapons systems that he employed for these achievements were based, not on physical firepower, but on psychological and political warfare methods, both defensive and offensive.

Defensively, it was necessary for him to counteract, negate, and sterilize our nuclear capability. Communist reasoning never forgets that a weapon—any weapon—is only a powerless bundle of matter apart from human minds and wills.

The biggest bomb ever built or building is less than David's slingshot without a mind and will and arm able and ready to use it.

With atomic capability added to our force already in being in 1945, we were in a position, materially speaking, to enforce our views, to reduce the Soviet threat to manageable proportions, and thus to guarantee for a reasonable future both national security and world peace. This possibility conflicted with the Communist objective of world domination, so the Communists struck back, hard, brilliantly, and successfully. The main impetus of their strike was directed against the minds and wills of men.

Their agents, dupes, and ideas were already present in many strata of American life, including scientific circles, the institutions that affect public opinion, and certain of the agencies of government. They were thus in a position from the very beginning to counteract our nuclear projects and capability—from the inside as well as through external pressures and diplomacy.

The main thrust of the first Communist reply to our nuclear weapons monopoly was thus psychopolitical, against the minds of the men who were making the weapons (technicians and scientists) and the men who controlled it (the leaders of government and public opinion).

> *"True political warfare, as understood and practiced by our enemy, is not mere rivalry or competition . . . of some vague kind. Political warfare is a form of war. It is strategic in nature . . . In simplest terms, it aims to conquer the opponent."*

The Communist objective was to deprive the United States of the political benefit of its nuclear capability, to "denature" the bombs, not by the physical process described in the textbooks, but by political, psychological, and moral means. In this case, as more generally, the Communists acted to confuse and disorient their enemy, to entangle him in contradictory policies, and to destroy his will to resist.

Under this defensive psychic screen, which successfully counterweighed their enemy's material superiority, the Communists went ahead systematically with the phased subjugation of the east European nations. At the same time, in a theater still more vast, they carried through the conquest of mainland China and its absorption into an expanded Soviet Empire.

ALTHOUGH there was, of course, fighting, some of it rather large-scale, the China campaign was essentially a political-warfare operation. (I am using the term "political warfare" in its most general sense, as covering all types of agitation, propaganda, subversion, economic manipulation, rioting, terror, diversionary diplomacy, guerrilla and paramilitary actions, etc.: everything, in sum, short of the employment of the main formal armed forces.)

The Communists' polwar campaign for the conquest of China opened in 1920. It was completed in 1949 without the mass intervention of the main armed forces and with a total expenditure of probably less than half a billion dollars.

Although most professional military men, unlike their civilian counterparts, know that we are in a fight, I get the impression that very few of them can take a weapon system seriously unless it comprises a lot of firepower. They can analyze learnedly the merits of strategic manned bombers vs. submarine-carried Polaris vs. railroad-borne Minutemen.

They will thoughtfully debate the role of conventional limited-warfare forces. They can envisage, without qualms, spending ten or twenty billion dollars to develop weapon systems

based on one or another or all of these concepts, together with the assignment of personnel and time and resources that go with money of that order.

But if you suggest—as I have often done in lectures at the various war colleges—spending any such sum, or a tenth such a sum, for systems based on Blanquist cadres, crowd manipulation, guerrillas, psychological warfare, paramilitary operations, subversion, bribery, infiltration, with specialized, mobile, ranger-type units in active supporting reserve—in short, if you suggest all-out political warfare (polwar)—the best response you can ordinarily hope for is a skeptical smile.

Yet it is the polwar weapons systems that have been winning all the battles. What good are Atlas and Polaris in Laos, Cuba, Algeria, the Congo, or in the swarming streets of Tokyo, Ankara, Jakarta, and Budapest?

IT has been demonstrated over and over again in the past fifteen years—indeed, since 1917—that modern polwar systems can smash governments and armies, and take over territory, peoples, and nations. Isn't a weapon system that can defeat the British, Dutch, and French armies, that can seize Czechoslovakia, China, and Cuba, worth spending a few billions on? The real worth of any weapon system, in the last analysis, should be measured by what it can accomplish, not by its size, complexity, cost, or physical firepower.

Naturally I am not suggesting that a polwar system should operate in a military vacuum. B-52's, Atlas and Polaris missiles are not being used, but the fact that they might be is a solid foundation for every kind of conflict operation. An effective limited-warfare arm, present always as a threat and ready for appropriate use, naturally strengthens any sort of political-warfare campaign.

A conflict apparatus adapted to the mid-twentieth-century struggle for the world consists of three primary forces, elements, or arms:

1. The massive retaliatory ("deterrent") force, which remains as the ultimate reserve.

2. The mobile, limited-warfare ("brush-fire") force. This, too, remains normally in reserve but in more active posture than the retaliatory force, ready for quick intervention in any area where security or interest requires the direct presence or use of military power.

3. The political-warfare force. This force—which by its nature includes a multitude of activities and agencies, both governmental and civilian—is the active vanguard. Under the shield of the retaliatory force, and backed up by the limited-warfare force, with which it collaborates, the polwar force continuously engages in the day-by-day operations of the protracted conflict.

True political warfare, as understood and practiced by our enemy, is not mere rivalry or competition or conflict of some vague kind. Political warfare is a form of *war*. It is strategic in nature. Its objective, like that of every other form of war, is to impose one's own will on the opponent, to destroy the opponent's will to resist. In simplest terms, it aims to *conquer* the opponent.

WITHIN the frame of that general objective, the specific objective of each specific polwar campaign is always defined in terms of *power*. The purpose in conducting polwar operations is always to increase one's power in some definite way or to decrease the power of the opponent. In either case, positive or negative, the aim is to alter the power equilibrium in one's favor.

The power objective may be grandiose—conquest of a nation, disintegration of an empire; or the minor takeover of a trade union, scaring a parliament into defeating a bill, or the sabotage of a factory. But whether big or small, the objective is always power.

These are the principles in terms of which our enemy has planned and mounted his polwar operations since the summer of 1903 when, through the founding of the Bolshevik faction, he launched his enterprise for the conquest of the world. Moreover, although he realizes that polwar in some instances

The eight-jet B-52 is part of the deterrent force which is our ultimate reserve (Air Force photo).

may not be able by itself to reach a decision and may have to be supplemented by full-scale military measures, he is convinced that in at least some cases political warfare alone *can* bring the decision.

By now he has ample evidence to support this belief. Czechoslovakia has been conquered twice in this century —once by Hitler and once by Stalin— by a purely polwar campaign, without the commitment of major armed forces. China also, as we have noted, was won essentially by polwar methods. By these same methods American nuclear testing has been stopped dead for more than two critical years.

Not a year passes but that these methods do not smash several governments. And right now they are swinging an island at our strategic doorstep into our enemy's power system.

Although we are in fact spending several billion dollars yearly on nonmilitary phases of the cold war, very few of these go for what can properly be called "political warfare" in the true sense—the sense accepted by our enemy. Our professional military leaders have traditionally regarded political warfare (or "psychological warfare," as it is more usually and inadequately termed) as being merely an auxiliary and relatively minor supplement to military operation.

The cold-war activities of nonmilitary agencies—"foreign aid," "truth (or information) campaigns," "student (or cultural) exchange," even much of the clandestine activity of CIA—are for the most part not true polwar operations. They are not political warfare because we do not really think of them as literally *war*.

WE are trying to get the better of a competitor and opponent, certainly; to block certain of his moves, divert others, influence him to make certain changes in his behavior and policies. But we are not trying to impose our will on him in any general way, and certainly we are not trying to defeat him.

In other words, we do not conceive our cold-war operations *strategically*. Often they have no clearly defined objective at all. When they do have an objective, this is seldom understood in terms of power.

In a genuine polwar system, foreign aid is only a key to open a national door for the conduct of field operations; information and propaganda are not a school lesson to teach pale truths about how nice one is, but a psychological weapon to undermine, divert, and injure one's enemy; student scholarships are not a charity handout to the needy, but a cover for training activist cadres.

Because we decline to fight genuine, strategically conceived political warfare, a considerable part of our billions in foreign-aid dollars has been wasted, squandered on useless projects, filtered into the pockets of corrupt local residents, or used to build up industry for the enemy or his friends to inherit.

Let me point the contrast by returning in conclusion to the specific matter of riots and mob action, bearing in mind that this is only one of a hundred polwar fields. How many men and women (women are exceedingly important in crowd management) do we have in training today for the mission of exploiting crowds, mobs, and street riots to our political advantage? Do we have *any?*

How many persons in the agencies of our Government have ever made a thorough study of the historical, psychological, and technical problems of handling mobs and mass riots? Is there even a single one?

The Bolshevik approach to mobs, riots, and "command of the streets" is very serious indeed. In his design for the revolutionary party—the conflict apparatus—Lenin, like Bakunin and Nechaev before him, incorporated the ideas of Louis Blanqui, a French revolutionist who lived from 1805 to 1881. Blanqui first became prominent in the 1830 revolution and devoted the rest of his life, in and out of prison, to revolutionary conspiracy.

He believed that the key to successful revolt was the development of a small, secret "cadre" organization. Normally the cadres would remain underground, abstaining from political affairs. They were to be trained in the manipulation of crowds and the use of small arms and improvised weapons (sticks and stones) accessible to crowds.

In the 1848 and 1870 revolutions in France, the practical cogency of Blanqui's ideas was proved. In 1870 it was his cadres who were primarily responsible for the overthrow of the Third Empire and the establishment of the Paris Commune—the first revolutionary, proletarian-led dictatorship.

DURING the past two years there have been mass riots in the streets of many major cities of the non-Communist world: Caracas, Montevideo, Lima, Baghdad, Havana, Capetown, Léopoldville, Algiers, Seoul, Ankara, Tokyo, Vientiane, San Salvador, and Saigon, among others. Nearly all have been directed against political friends of the United States or against policies favorable to the United States.

Besides promoting fiercely anti-American attitudes, these riots played an essential part in the overthrow of no less than eight governments that were firm allies of the United States: in Venezuela, Iraq, Cuba, South Korea, Turkey, Tokyo, El Salvador, Laos. The governments were overthrown just as thoroughly as by outright military defeat. Unguided mobs may shake but they do not overthrow regimes. They do not spontaneously produce consistent slogans and select strategic targets.

The coordinated operations of these recent riots, and their high measure of success, are the product of trained Bolshevik neo-Blanquists.

In the next year or so the Communized government of Cuba will either be overthrown, or the enemy will move on to the staged take-over of Central and South America. In the next year or so, non-Communist regimes must retain power in the Indochinese successor states, or the enemy will move on to the staged take-over of the entire Southeast Asian peninsula.

For both operations, H-bombs are useless. Is it not obvious that we are not likely to meet either of these challenges unless we decide to lift our Cinderella political-warfare system from the scullery floor where we have so far left her in rags and tatters?

New Trend in Weapons

Reliance on massive retaliation gives way to mobility and firepower

Mark S. Watson

AS the new Congress assembles, the Pentagon program begins to take on a new characteristic. The quest for new and far more massive weapons continues, as it must, so undeniable is the need for massive powers of deterrence and retaliation. But with it, and thanks very largely to the insistence of Congress itself, the Army in particular is beginning also to acquire in greater variety and volume the not-so-massive equipment for which the Army's leaders have been arguing for years in their quest for mobility plus firepower.

"Beginning" is the right word. That Gen. Maxwell D. Taylor's term in the Joint Chiefs of Staff was not extended (as has sometimes been the case with a Joint Chief) may have been due in part to his vigorous public insistence that the Army was in far more critical need of modernization through rapid procurement of weapons and equipment than the Administration admitted. He urged procurement of new-type weapons and equipment to the extent of $3,000,000,000 a year for 5 years.

What Congress provided this past year fell far short of that impressive total, but three aspects of the appropriation for Army equipment procurement in fiscal 1961 force themselves to attention:

1. The total was the largest since 1954 (when Korea's painful lessons were influential).

2. It was appreciably larger than the President's request.

3. There is every indication that instead of withholding a large part of it, as was conspicuously done in the past, the Defense Department is releasing all this money to the Army for contracting out as rapidly as the Army can make its own decision on exact priorities and obtain approval from the Joint Chiefs.

Mr. Watson is a well-known military analyst and correspondent on the staff of the Baltimore Sun. He holds the 1945 Pulitzer Prize for international correspondence.

Ours not to reason why this last is true, or even to conjecture that it might be related dimly to election-year considerations. Rather there is satisfaction in noting that the swing away from almost total reliance on massive retaliation has begun. The wisdom of possessing multiple defenses, urged by high commissions of qualified civilians in impressive succession, proclaimed by Gen. Matthew B. Ridgway in his day at the Pentagon quite as boldly as by his successor General Taylor and eventually (in an election year) pressed by authoritative members of both Houses of Congress, Democratic and Republican alike, has at last made its way into public consciousness. The result is that the Army is beginning to get some if not all the new types of modern equipment it requires in encouraging (but not yet satisfying) quantity.

The situation and the prospect were lately summarized by Lieut. Gen. Paul L. Freeman, in his very candid remarks before the Joint Civilian Orientation Conference at Fort Benning:

"Equipment (he was speaking at that moment of communications) is available. The dollars to buy it are not. . . . Industry and science are making great strides in offering us solutions that will greatly enhance the combat potential that the Army is striving to develop within its manpower ceiling. The facts of life being what they are, however, it will take a great many more dollars than the Army has seen for a number of years to get very much of this new equipment from the developmental stage into the hands of troops. Meanwhile we are becoming quite practiced at making do as best we can with the resources available."

IN 1960 there was a good deal of difficulty in "making do." The Pentagon's high fiscal authorities simply declined to release to the Army the $175,000,000 which Congress had added to Presidential requests, and beyond the formally budgeted purchases only $43,000,000 (as Senator Lyndon Johnson's Preparedness Investigating Subcommittee pointed out in its June 24, 1960, report) was actually granted for the much-needed modernization.

Against that dismal reality of fiscal 1960 the Congress again (in its fiscal 1961 appropriation) noted the President's budgetary request for $1,524,000,000 in Army procurement and abruptly asked Army witnesses to state what else they needed. Tempering General Taylor's earlier estimate, the new Army spokesmen suggested $2,500,000,000 as a proper total in modern weapons and equipment for 1961 allotment and submitted a specific list of the priorities upon which it would ex-

pend an added $928,000,000. This, added to the President's $1,524,000,000 request, still fell short of $2,500,000,000, but it was much more than Congress was prepared to add. The final budget added, instead, a modest $158,300,000, and it is interesting to see how that has been disposed of thus far.

The process requires the Army itself to make its selections of what, on one count or another, it will add. This selection is not final, for the Defense Secretary, normally with the Joint Chiefs' concurring recommendation, has the final power to release the money. Defense Secretary Thomas S. Gates, Jr., long ago gave assurance that none of the total is to be "frozen," as in 1960, but released, item by item, as approved. The Army's selection has not been easy, for the supplemental list sent to Congress (the hopeful $928,000,000 total) contained 54 items, and with only one-sixth that amount of money in the final grant, relatively few items could be acquired.

The first release from the promised $158,300,000 was of $37,100,000, which covered the contract cost for 120,000 additional M14 rifles and 200 million rounds of 7.62-mm. ammunition, which fits the new M60 machine gun as well. In that initial request is sufficient indication of how strongly the Army feels about rapid acquisition of the new small arms, two types of which will eventually replace six old-type weapons.

The second release of the "add-on" money, $28,200,000, permitted contracting for additional M60 tanks and the ammunition for the new 105-mm. guns they will mount and also a small supplemental purchase of the much-needed 90-mm. recoilless rifle.

THE third release, of $25,200,000, covers 3 items. One is the infrared fire control for the M60 tank, which is a major factor in that vehicle's impressive promise. Another is for more M113 personnel carriers, the new and highly mobile vehicle which is a fit task-force companion for the M60 tank. A third item is an entirely new and notable blessing to the infantryman, which the Ordnance Department rather surprisingly did not unveil publicly until last October, the XM79 shoulder-fired grenade launcher. Some of its remarkable attributes will be discussed later.

These three releases totaled $90,500,000 leaving $67,800,000 of the congressional "add-on" still awaiting allotment—but certainly not "frozen," the Defense Department says with emphasis. At the moment of writing, it appears that the residue is to be sought, and presumably granted, later in the fiscal year for items which are not yet finally field-tested—or, in case of recalculation, something which at that time may conceivably emerge as still more vitally needed. A reasonable assumption is that the bulk of the residue will be put into the new self-propelled artillery, of which more will be said hereafter.

Looking back over that short list of items in the add-on contracts, one sees

no "massive" weapon employable only in an all-out war. Every item is usable either in conventional war *or* in phases of the dreaded total war. Every one is an element in mobility plus firepower. Every new weapon continues the forward lunge in firepower.

The pace of modernization obviously is still far slower than Generals Taylor or Ridgway or Lemnitzer or Decker would wish, and the moderate volume of acquisition is disturbing. The slower the pace, the less will be the uniformity of equipment with the loss of all the virtues of uniformity—relatively easy deployment of all troop units, economy in training of personnel, efficient logistics whether for supply or resupply, or maintenance and repair in the field.

Sometimes an insufficient distribution of new weapons can raise disturbing problems for a theater commander, and this consideration must be present as one surveys the slow progress in modernization to which the Army is limited by fiscal realities. The Johnson report of last June bleakly listed the Army's possessing, as of that date, one-sixth of its requirements for the basic M14 rifle, none of the 90-mm. recoilless rifle, and but one-third its needs for the M60 machine gun in production, one-fifth of the personnel carriers and one tenth of the M60 tanks on order, and not even one of the new self-propelled howitzers on order.

In missiles the report noted "substantial" quantities of Little John needed, one-sixth of Sergeant requirements contracted, just two Pershings on order, one-third of needed Hawks in production, "hundreds of Davy Crocketts when thousands are needed," and no Redeye in the hands of troops.

Without concealment of these facts or contentment with them, one still may look with a good deal of satisfaction at what is being done with the monies granted.

The spectacular aspects of the new M60 tank and its comrade, the M113 personnel carrier, were referred to in an earlier review of modernization prospects (ORDNANCE, September-October 1960, "The New M60 Tank," p. 193). The efficiency of the new rifle and machine gun which, among other virtues, will satisfy a major NATO requirement, is becoming clear, and it is gratifying to see that the Nation's production capacity (whether or not fully employed) will shortly be in excess of 300,000 rifles a year.

The other two items covered by contracts under the money releases to date are the 90-mm. recoilless rifle and the really astonishing new grenade-launcher. Neither is yet with troops. None of the self-propelled guns (which presumably will be contracted for in the spring with most of the still-unreleased appropriation money) is even on order. There may therefore be particular interest in several modernization items on the way now or in the fairly near future.

XM79 Grenade Launcher.—When this weapon goes to troops in coming weeks, and in fair quantity for a brand-new weapon, it should prove one of the most welcome. It is free of complexities ("the simplest known weapon" says an enthusiast—who has forgotten about the shillelagh) and hence calls for a minimum of troop training in either operation or maintenance. It is fairly accurate to 400 yards, and lethal for a considerable distance around its explosion point. It is so far superior to the present rifle grenade launcher that they simply are not comparable.

Rather its effect is much like that of the once-familiar 60-mm. mortar, but its precision, mobility, and flexibility are in a far higher class.

The lightness of the weapon (6 pounds, 2 ounces) which has the look of a sawed-off shotgun, is due to its aluminum barrel—the first, by the way, in American use. The 40-mm. cartridge also uses an aluminum casing for the 6-ounce projectile, and one would guess that the score or more in the load the operator will carry with him in a shoulder-slung bag will be determined more by bulk than by weight. The loading, by breech, is with single cartridges, making four a minute the approximate speed of fire.

It is expected that one or two of these weapons will be carried within the infantry squad, which thereby will acquire such independent firepower as many an infantryman must have yearned for in emergency. The wire-wrapped projectile's lethality is from fragmentation as much as blast, for it is calculated to burst into some 300 pieces at high velocity.

M60 Medium Tank.—This a very considerable advance over the existing Patton, largely through three major characteristics: (1) its diesel engine provides far greater range, greater simplicity, less vulnerability through ignition of its fuel tanks; (2) its new 105-mm. gun provides a firepower that is unexcelled by any tank; and (3) its promised infrared fire control will give unprecedented night-fighting powers.

It certainly is not the last word in tanks (a marked improvement in the form of a radically new design seems destined by 1965), but it was adjudged the best tank available today and hence a solid requirement. There are 1,080 on order, and this must be related to stated needs which are 306 for an armored division and 92 for an infantry division.

M113 Armored Personnel Carrier.—This is an impressive example of first aid toward the field mobility which is a prime aim of a modern army. The vehicle, carrying thirteen men, can move the same payload as its predecessor, but it weighs half as much. Hence it is air-transportable, deliverable by parachute, and amphibious. It has a

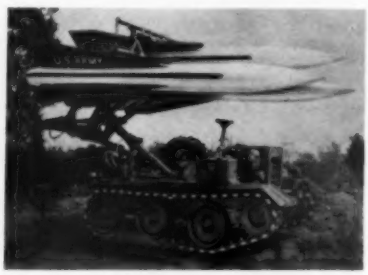
The air-transportable M113.

road speed of 40 miles an hour and a range of 200 miles, which means that it is a fit companion of the M60 tank. Present contracts are for 2,280 vehicles. Present tables of equipment allot 536 to an armored division and 174 to an infantry division—a sufficient indication of the moderate pace of field distribution.

New M14 Rifle.—The points of superiority of the M14 rifle over the existing M1 have been described countless times. Outstanding is the identity of caliber with the new machine gun and with new small-arms of NATO allies as well providing a mammoth advantage in logistics and training, in reduction of the number of types of weapons and ammunition. On order are 205,000 for the Army (plus 63,500 for the Marines) with 120,000 added by congressional insistence. Tables of equipment prescribe 11,874 for an infantry division, 9,508 for an airborne division, and 11,493 for an armored division.

New M60 Machine Gun.—Here again the great virtues are uniformity with allies' weapons and the ability of this one weapon (as with the M14 rifle) to replace several existing weapons types, with corresponding advantages in training and logistics. On order for the Army and excluding the Marine Corps are 18,480 from 1960 money plus 12,000 from 1961 money. Requirements are 561 for an infantry division, 438 for an airborne, and 644 for an armored division. First to be equipped with both rifle and machine gun is the 101st Airborne Division.

Hawk Surface-to-Air Missile.—This is a notable weapon of defense against aircraft and air-breathing missiles, particularly in low-level approach. Its agility was early demonstrated by its kill of an Honest John missile, this being the first recorded destruction of a supersonic missile. Hawk later killed a Little John, which is a still smaller target. The number of Hawks contracted for is classified, but the magnitude is suggested by the announced total of dollars contracted to date, which is $517,000,000. There has been announcement of the activating of four battalions (a battalion has six triple launchers), the deployment of two of them to the



Mobile loader moves Hawks into position.

Panama Canal, and preparation of eight sites on Okinawa.

Lacrosse Surface-to-Surface Missile.—An extremely powerful weapon for use against strong points and concentrations, this is the first Army guided missile developed for close support. It employs varied warheads and is air transportable. It already is deployed in

Lacrosse missile ready to fire.

Europe. Again, the numbers produced are classified, but the contracts total $156,000,000.

Recoilless 90-mm. rifle, M67.—This is a superior antitank weapon, assigned to the combat-group platoon to replace the Korean-type bazooka. One thousand are now on order. An additional thou-

sand were asked for but not allowed. Army requirements are for 3,500.

Honest John Rocket, M31.—The improved type, still under development, will mark a very great advance, as will be discussed a little later. Meantime, production of the present type continues, with $2,800,000 worth of components ordered in June. No more orders are anticipated.

The New Honest John System.—In the foregoing list the procurement has been of weapons and equipment now

Honest John surface-to-surface rocket.

in the production stage and largely in distribution as well. Of very great interest is the large expenditure for several items not yet fully emerged from development but so near to readiness that their capabilities can be discussed publicly, and with profit, so large is their promise of contributing to the total of Army modernization as soon as funding permits.

In the realm of field-army firepower, one must put the XM50 close to the top, partly because it has passed its engineering and field tests and could be going to the Seventh Army before very long. This is a very much improved Honest John, its superiority made possible by long and methodical planning.

Today's Honest John (M31) was a hastily contrived weapon rushed to readiness when Korean worries were acute and any sort of massive complement to our field artillery was urgently needed. This 1951 design, accordingly, made maximum use of on-the-shelf items which could be quickly matched together. One part was a crude rocket patterned on a German experimental type. A part of the M6 Jato, which the Navy was using for a wholly different purpose, was a useful addition. The launcher was a simple track welded to an existing light truck.

Yet what emerged, thanks to Ordnance dexterity and judgment, was a device so practicable that it remains useful to this day and—most notably in our period of deterrence—provided the United States with its first possibility of linking a nuclear warhead (it also uses conventional warheads) to a mobile surface vehicle.

By 1955 it was recognized that this patchwork, potent as it was (and is) should be replaced. The XM50 is not an improved version of the old Honest John but a totally new rocket. Nothing of the old is used, not even a pin. Yet a casual look fails to disclose the newness, save in the greatly altered fins. With such close approximation of the old dimensions, the new Honest John can be fired from the old launcher and the old Honest John from the new one.

For all this apparent likeness the XM50 will have a significantly greater range than the M31's sixteen miles, greater accuracy, and greater reliability, whether for storage, handling, or firing. The missile is lighter—4,700 versus 5,800 pounds. The powder itself is superior by quite a degree. The whole system has rugged powers which enabled it to pass arctic and tropical tests alike.

It is therefore more easily prepared for firing, allows faster loading, and is easier to maintain, repair, assemble, and check. Its bolts, one notices, are placed where they no longer impede handling. The missile also has a potential for growth in the near future—and all this is at comparable cost.

So much for the missile. A huge additional advantage comes with the new M405 loader, which really is transporter and loader combined, yet weighs but 34,000 pounds against the M289's 44,000. No longer must an Honest John battery rely in emergency on Ordnance's handy all-purpose wrecker, which has plenty of other things to do. Thus the new weapons system makes a large contribution to a modern Army's mobility as well as to its increased firepower.

New Little John, XM51.—The present Little John (M47) was devised as a readily air transportable substitute

The Little John rocket and launcher.

for the older and heavier Honest John. It, too, has benefited from redesigning time, plus metallurgical developments. The new version, now in advanced development, puts its emphasis on increased accuracy, rather than on added range, with appreciable lightening of the launcher, which now weighs 1,270 instead of 1,700 pounds, making it that much easier to lift by helicopter.

The accuracy is achieved largely by assuring alignment in initial flight through imparting of a prefiring spin which is something of a marvel in technology. The warhead is substantially improved, explaining readily enough a 23-inch increase in over-all length in the case of one type of round. It, like the Honest John, has atomic capability but also uses high-explosive and chemical warheads.

Altogether this is a very mobile weapon, indeed, highly sophisticated, carrying a solid punch, and heartily welcomed by the Strategic Army Corps units which will be first to get it. So sure was Ordnance about its development that the rocket went through engineering and user tests at the same time and was publicly and proudly shown both at Aberdeen Proving Ground and at the Project Man show.

Little John is not a substitute for Honest John, for each has its merit. Honest John requires a more powerful lift and a longer time for emplacement, but it has a mightier punch. Little John's remarkable mobility is purchased by sacrifice of range.

Self-Propelled Guns.—Still in development, but not far from production, are the new types of self-propelled guns which Ordnance expects to mark a very great advance over existing types. Our World War II types, it must be re-

membered, were produced at great speed and had the inescapable weak-

Self-propelled 105-mm. howitzer.

nesses which come from haste. The prospective users of this type of weapon two decades ago were slow to make up their minds on what they wished, and the first weapons to come into use were, naturally enough, adaptations rather than full design—pretty much an existing gun mounted on an existing tank chassis.

The second wave was an example of trying to develop complex weapons without experience as a guide, and it was some time before there was recognition that the self-propelled gun does not require as much protection as a tank and is handicapped if it has it. Only then were designers able to start with fundamentals and evolve a chassis singly suited to a gun rather than to both a gun and tank. Even so, the disputes between users and designers in the post-1945 period were lively.

Now we begin to see the T195E1 (for the 105-mm. howitzer) and the T196E1 (for the 155-mm. howitzer—see photo on page 500) using an identical chassis, lighter, lower, shorter, and narrower than its predecessors and therefore consuming less fuel or, alternatively, getting more range. This type is air-transportable by C-133, and its aluminum-alloy armor affords the same protection with much less weight —45,000 instead of 62,000 pounds. The "E" symbol marks it as a diesel and suggests a likelihood that the new vehicle's travel range will double its predecessors', making it a fit comrade of the diesel-powered M60 tank.

Under development, too, is the self-propelled 175-mm. gun (T235). Here there is in prospect what our Ordnance experts firmly believe to be the best gun of its type in the world. While its powers would seem to call for a weight of 100,000 pounds, this new weapon weighs but 55,000 so that it can be moved by railroad and thus go anywhere in the world, whereas the old one could not be shipped unless disassembled.

Missiles.—Pershing IRBM, which is to replace Redstone, is still in the advanced development stage. Its fitness for the 200-mile mission to which the Army is still officially (but less firmly) restricted does not seem in question. Rather there is a possibility that this scientifically developed child of Redstone Arsenal will acquire much longer legs. News dispatches from Project Man

The Pershing missile on mobile carrier.

reported General Lemnitzer's calm assurance to the President that in this case man can, by thinking, add a good many cubits to its stature—provided the thinking is supported by cash.

Nike Hercules, now rapidly replacing Ajax, continues to impress observers. Running out of other targets, it proved its merit by killing another Hercules, having already downed some less-formidable ballistic missiles, effecting its kills as high as 19 miles and at a range of 32 miles, with a closing speed of Mach 7. An improved Hercules is on the way.

Zeus, third in the Nike series, and a far bigger enterprise than Ajax and Hercules, continues in development, still suffering from a Defense Department economy attitude as far as production money is concerned, yet being granted all that is needed, apparently, for research and development. We have thought of it as a defense system so vast that it was a sort of continental defense. In addition, this past October study contracts were announced which look toward a new mobile missile defense system, on some distant day, for field-army defense.

The Defense Department has remained obdurate about releasing any of the $137,000,000 production-preparation money which Congress granted for Zeus more than a year ago, but has not opposed lively spending for purely "development" purposes. This included a single release of $199,000,000 last autumn; also approval of test preparations both in the South Atlantic and in the mid-Pacific.

Davy Crockett.—More and more this tactical weapon, providing a unit as small as the infantry battle group for the first time with a low-yield atomic-weapon capability, is emerging from its cover. It has two versions, one weighing 200, the other 400 pounds, both being recoilless rifles firing projectiles whose heads are larger than the attached "pistons" which slide into the gun tubes. Both types will be mounted on highly mobile vehicles.

Redeye.—Another of the infantryman's new weapons with power quite disproportionate to its size is Redeye, also in advanced development, which arms the ground soldier against low-flying aircraft. It is fired from a bazooka-type launcher, is four feet long, and weighs twenty pounds; hence it can be

Redeye antiaircraft missile launcher.

carried through brush and over surfaces impassable for any other weapon of such powers.

Sergeant.—This replacement for the pioneering Corporal excels its predecessor in power, reliability, mobility, and accuracy. It has the virtues inherent in the new solid fuels (Corporal uses a liquid propellant). Its 75-mile range (like Corporal's) provides a field commander with an atomic punch of great importance.

The real shortage is in procurement funds. "Battlefield equipment is available. The dollars to buy it are not."

Our Missiles Are Mighty

Despite strong Communist propaganda to the contrary, America has the world's greatest guided-weapon capability while our space vehicles and satellites far outnumber those of the Soviet Union

Rear Adm. J. P. Monroe

Admiral Monroe is Commander, Pacific Missile Range, Point Mugu, Calif. This article is based on a recent address by Admiral Monroe before the A.O.A. Electronics Division at Point Mugu.

AMERICA'S future economic strength, as well as our national security, depends on our continued scientific and technical leadership. We face able, alert, and determined competition from abroad—not only technical competition, but the much more dangerous competition between the Communists and the free-enterprise system.

Every informed man is under obligation to speak out on urgent issues, and this is what I propose to do here. The cold war being waged by an agressor nation forces us to live in a troubled and upset world—a world experiencing great changes. One of the most significant of these changes is the compression of time. Scientific breakthroughs used to occur once in a generation; they now happen at bewilderingly short intervals.

In every field of science the spiral of progress is tightening and speeding up. We are fortunate, indeed, to develop and test a new weapons system before a better one comes along behind it to make it obsolescent.

WE are trained to believe that the fruits of science belong to all men. Nothing could be truer or more useful in a peaceful world, but we are not in a peaceful world by any means. We are in a bitter fight for survival with a system dedicated to the destruction of our freedom. Common sense and our basic instinct for survival dictate that we deny our scientific advantages in weaponry to the Communists.

To maintain our military superiority it is essential that we maintain adequate security for these new technological secrets. In this field we can outstrip Soviet science, providing we refuse to share our scientific discoveries with the merchants of slavery.

The Communists have told us by words and deeds of their intentions toward the free world. When future historians analyze our record, our accomplishments, and our failures, let us hope they will not have to record that we refused to believe the Communists —that we disregarded their plain warnings and aided and abetted in our own destruction.

The diplomatic cold war being waged at the United Nations is getting considerable publicity. Another area which is not receiving such publicity is the bitter competition for the conquest of space. I wonder how many of us realize the full implications of this struggle?

As Dr. Killian so clearly stated recently, the nations or group of nations which in the past have controlled the seas have controlled world policy. It now appears that in future decades the nation or group of nations dominant in space will dominate world policy.

The military forces of the United States propose to use space for two general purposes. First, we are going to use space to assist us to do our military job better, initially, through the use of satellites such as Transit, our navigational satellite. We likewise need a communications capability, a weather-forecasting capability, and an early-warning capability, among others. Secondly, we are going to ensure that no aggressor uses space to the detriment of our military task.

AS Pacific Missile Range Commander, I am intimately concerned with the military satellite and space programs of the United States. I am concerned over the amount of misinformation and the number of uninformed people who are discussing these matters. Americans should be proud of our achievements in space and of our military capability. Wherever Americans go in the world, they should hold their heads high because they are citizens of the greatest country in the world.

In order to put this picture in a better perspective, I would like to give my personal opinion of the military capability of the United States and of our achievements in space and compare

these achievements with those of the Soviets. In order to simplify such a discussion, I will divide space into three purely artificial areas: the guided-missile area, the satellite area, and the deep-space area.

In the guided-missile area the United States has effective operational weapons in every category. In the air-to-air category, we have the Sparrow, the Sidewinder, and the Falcon series. In the air-to-ground area we have the Bullpup, a very simple, effective off-the-shelf item. In the surface-to-air category we are taking the guns off our cruisers and replacing them with Terrier missiles; we are taking the guns off our destroyers and replacing them with Tartar missiles; we are ringing our major cities and critical military sites with the Nike Hercules.

In the surface-to-surface category, we have a whole family of guided missiles, starting with the hand-carried antitank weapons SS-10 and 11, the 12-mile Honest John, the 75-mile Corporal, the 200-mile Redstone, the 500-mile Regulus I, the 600-mile Mace, the 1,500-mile Thor and Jupiter, and the 6,000-mile Atlas—which has demonstrated 9,000-mile capability.

All these missiles have passed their tests, are operational and ready for war use. We do not have all of them in the numbers we would like, but they are in production, and time will cure this. Some of them have deficiencies, but I must remind you that we are in the kindergarten of the missile age. These are largely first- or second-generation missiles, and we would expect them to have some deficiencies. I can assure you that from my knowledge of missile development and testing the Soviets must likewise be having missile troubles.

HOW about the so-called missile gap —the report that Russia has produced more large missiles than the United States and is capable of producing such missiles at a faster rate? The United States has specific military requirements, and we tailor our armed forces to carry out those requirements. Russia has an entirely different set of military requirements. There is no reason that the armed forces of the United States or those of Russia should resemble each other in size, types, or numbers. There is no reason for us to match Russia missile for missile, ship for ship, soldier for soldier, or tank for tank.

I can assure you that the United States has the greatest military capability the world has ever seen, ample to inflict unacceptable damage on any aggressor. I also can assure you that we do not intend to add unnecessarily to our military capability nor do we intend to buy missiles which we do not need. There is no sense in killing an enemy twice.

We also realize we are not in a static business. Backing up each of our missile systems are better systems under test; still better ones under development, and far better on the drawing boards or under discussion. The Polaris, which is now operational, is an excellent example of our spectacular missile progress.

As an example of it not being necessary to match Russia weapon for weapon, I would like to point out that the Soviets have about 450 submarines. They have these submarines because they realize that in case of war they must cut our seaborne supply lines and destroy the convoys which supply the war area with ammunition, petroleum, troops, and supplies of all kinds from our great production centers. If they cannot interrupt these supply lines, they will lose the war.

We do not need 450 submarines because in case of general war you would seldom see a Soviet surface ship out of sight of land.

Let me remind you that these great deterrent weapons which we have developed and which are ready for use are no good to us if the American citizen is not mentally prepared to use them and if we don't convince the aggressor nations that we are so prepared. We don't want to use them, and they have failed in their purpose if we do, but if we are forced to do so, we must use them.

If we are so prepared, I guarantee that we will never have to use them. If we are not so prepared, we will be subjected to nuclear blackmail for the rest of our lives—blackmail which can only be paid by concessions to the aggressors.

How can I state so positively that if we are prepared to use them, we will never have to? I can give you a very homely example of my reasoning. Last year there were approximately fifty thousand armed robberies in the United States. Of these fifty thousand robbers, only three were so misguided that they tried to hold up policemen—and these three are now available for interview in one of our better correctional institutions.

It is a characteristic of human nature that you do not pick a fight with a guy so tough he can knock your block off. This was true in the Stone Age, it is true now, and it will always be true as long as there are human beings.

There are worse things than nuclear war—to become a slave state of Communism is far worse. The fear of atomic war is worse than the reality. Fear is the thing that gives the bully his effectiveness, and this is what the aggressors are constantly trying to instill in the people of the free world, particularly the United States. I am confident that we have the courage and integrity not to let fear erode our faith in our institutions.

NOW let's take a look at the satellite area. Here the United States is clearly ahead of the Soviets. We have launched to date twenty-eight successful satellites or deep-space probes—satellites like Tiros, the weather satellite; Echo, the communications satellite; Transit, the navigation satellite; and deep-space probes like Pioneer V, which is orbiting the sun today.

The Soviets have launched eight such successful shots, although from the amount of propaganda that has been put out on those eight shots you might very well think it was closer to eight hundred.

Of the twenty-eight United States shots, sixteen are still orbiting the earth today, nine of them alive and talking back to us. The Navy alone has as many operating satellites in orbit as the rest of the world put together; namely, Vanguard I, the two Transits, and the piggyback satellite which was launched with one of the Transits.

How many payloads do the Soviets still have in orbit? One dead satellite orbiting the earth and one dead satellite orbiting the sun. From our satellites, the United States has extracted many, many more times the scientific information from space than the Soviets have.

NOW let's take a look at the third area, deep space. Here we see an entirely different situation. The Soviets are clearly ahead of the United States and they are ahead for one reason and that reason is *foresight*.

We now realize that at the end of World War II the men in the Kremlin sat down and, in their usual calculating manner, analyzed their military future. They decided to leapfrog from the World War II bomber over the intercontinental bomber, which we bought in such large numbers, into guided missiles. They estimated the size of the nuclear warhead they would have when they could develop a booster to launch it, and they developed that booster.

This booster turned out to be about twice as large as our largest operational booster—on the order of 800,000 pounds of thrust—and with this great thrust the Soviets put into orbit in 1958 a weight which we are not able to duplicate, a weight which we will be unable to duplicate for at least one year and possibly two.

This is an impressive engineering achievement. What is its military significance? It is exactly zero. With our Polaris and Atlas warheads, with their capability of devastating a city in one hit and equipped with boosters which will send them as far as we are ever likely to want to send them, we would have no military use for a large booster. If we had it we would use it for the scientific investigation of space, to put man on the moon, to examine the planets, etc.

Whether we like it or not, the world is far advanced into the Nuclear Age, and we are rapidly going farther. This is an irreversible process—we cannot back out of the Nuclear Age even if we wanted to—certainly not unilaterally.

The confusion which has existed regarding our military capability and achievements in space has naturally generated criticism of the Defense Department, and powerful and articulate groups can be expected to take advantage of this situation to push two potentially disastrous proposals.

One is to replace the Joint Chiefs of Staff with a single Chief. The second is to put all military men in the same uniform. One of the advantages cited is that it would stop interservice "bickering." I agree with General Ridgway when he stated that the so-called "bickering" is, with few exceptions, a source of great national strength; that it is the expression of honest conviction by men of courage, integrity, and competence—by men of tremendous capability who have dedicated their entire lives to mastering the intricacies of one of the military professions.

As long as we need to control seas we are going to need admirals to lead our task forces at sea; as long as we need soldiers, we are going to need generals to lead our armies in the field; as long as we need manned aircraft, we are going to need generals to lead our air fleets. Putting everyone in the same uniform will not change these requirements.

"The Polaris is an excellent example of our spectacular missile progress."

As far into the future as anyone can see we are going to need these unique capabilities which take a lifetime to develop. Why suggest throwing away the traditions and the morale built up through generations by each service by shifting out of our present uniforms and changing to the dead level of one uniform?

Worse still, these proposals strike at one of the basic concepts of the American form of government which is not to concentrate power unnecessarily, particularly military power. Lord Acton truly stated, "Power corrupts; absolute power corrupts absolutely." The single Chief of Staff and the single service are, in my opinion, major steps toward a dangerous concentration of military power which history has repeatedly demonstrated is most unwise. Every country that has taken this step has lived to regret it.

Space must have an ever-increasing role in the future plans of all the services. Any service with no mission in space faces a most precarious future. There are in all services dedicated, misguided, shortsighted officers who are pushing hard for one-service control of space. This alarms the other services who realize that the doctrine of one-service control is disastrous folly.

I KNOW the competition for missions in space distresses and concerns you as it does me. How can we get these aggressive military men to work together harmoniously?

By the way, the *aggressive* military man is the only one of any value to us. He is the only one who is really useful in war. We must, therefore, put up with him in peace, as difficult as it sometimes is, since one of the characteristics of an aggressive military man is the outspoken expression of his convictions.

One way to ensure that all services will work harmoniously together in space is to set up a joint space command, making each service an equal partner. There is an excellent precedent for this: After World War II we faced up to the problem of how to use the military applications of atomic en-

ergy. We set up a joint command which is headed up by an admiral for one tour, an Army general for the next, and an Air Force general for the next. Some of the major staff jobs are similarly rotated. I defy anybody to name a major interservice fight connected with the military use of atomic energy.

THE joint command makes sense from another angle because all services have identical military requirements in space. Every service needs an all-weather navigational system; all services need a 24-hour-a-day worldwide meteorological reporting system; all services need a communications system which will permit reliable communications from any one point on the earth to any other point on the earth twenty-four hours a day.

All services need an early-warning capability which will advise them any time a ballistic missile is fired anywhere on the surface of the earth, and all services have similar requirements for observation satellites. As time goes on, all services will have identical requirements for whatever manned space vehicles are required.

Finally, let us examine briefly the losses if any service had been excluded from guided missiles and space up to the present time.

Without the Navy we would not have three Vanguards in orbit—the first of them the most stable of our satellites and which will probably be in orbit longer than any existing satellite. We would not have two Transit navigational satellites in orbit with the prospect of the earliest operational satellite system. We would not have a mobile invulnerable seaborne deterrent system such as the Polaris. In fact we would have been far behind in our solid-fuel capabilities. We would not have the very effective Dark Fence satellite-detection system.

Without the Army we would not have had our first satellite, the Explorer, in orbit as soon as we did. Our great mix of deterrent weapons would be sadly depleted without the Honest John, the Corporal, the Redstone, Jupiter, Nike Hercules, and many others.

Without the Air Force we would have no intercontinental ballistic missile such as the Atlas; we would not have a Thor missile, the most useful of the small boosters for space work.

Throughout history, man has sought for the ultimate weapons system, one for which there is no defense. It is probable that no perfect weapons system ever will be developed. While it is true that all advanced offensive weapons enjoy a temporary ascendancy over the defense, historically, defense always has caught up. However, at the present time offense is so far ahead of defense that many of our most able scientists and missile men feel that defense can never catch up.

This fall the Navy added a gigantic punch to our offensive power by the most useful mobile deterrent weapon developed to date. I refer to the 1,200-mile solid-fuel Polaris which can be fired from a submerged nuclear submarine. On July 20th the Navy accomplished an historic military "first" by firing two operational Polaris missiles from the GEORGE WASHINGTON submerged in the Atlantic. This was the culmination of five years of intense Navy effort.

Since then, there have been many Polaris firings, mostly successful, some only partially so. I deplore the second guessers, pessimists, and the prophets of doom who shift from being warm supporters of a system to critics, depending on the success or failure of a shot. Informed men realize that it is statistically certain that every test shot will not be completely successful but that much is learned from each shot, even from the so-called failures.

This fall, the GEORGE WASHINGTON slipped quietly to sea and submerged on patrol duty with sixteen Polaris missiles on board. It will be followed by the PATRICK HENRY with sixteen more missiles. Approximately every four months thereafter, another nuclear submarine will go to sea with sixteen more missiles on board, until we have a total of some forty-five Polaris nuclear submarines.

The part of this force that is kept at sea will be capable in itself of devastating any of the aggressor nations. We will have a mobile invulnerable force roaming the world's seas which will ensure that any aggressor foolhardy enough to attack the U. S. will suffer certain return destruction.

Mobility always has been a most important military capability. It has assumed increasing significance in the ballistic-missile age because ballistic missiles are aimed at a specific point on the surface of the earth and, once committed, the impact point cannot be changed. Therefore no one would fire a ballistic missile at a moving target since it would be a wasted effort. The Navy always has believed that the way to fight a war is to take your ammunition as close as possible to the enemy before you fire.

In the Polaris we have a simple, reliable, solid-fuel, instantly ready missile which is fired from beneath the ocean far from the population centers of this country.

IN closing, I would like to emphasize a final point. I find that many people in this country are still confused as to the real intentions of the Communists.

They see the character of the cold war constantly changing, sometimes tough, sometimes peaceful. They are irritated by Communist propaganda which changes so erratically and so violently. They ask, "How can you judge the intentions of the Communists?" Certainly not by what they say, as this changes daily to fit the existing world situation.

I recommend you judge the Communists by what they do—by their deeds. If they ever sincerely want peace, they will demonstrate this desire by peaceful deeds. Up to this time, I have seen no major significant peaceful move by the Communists in their entire forty-three years of history.

So until we observe an unmistakable demonstration of a real desire for peace on the part of the Communists by a succession of peaceful deeds over a considerable period of time, our only security is our military and economic strength. We must not reduce either. They are the only things which give a sense of confidence and stability to the free world. They are our only chance for a lasting peace.

Defense Must Be Adequate

Our military programs should not outstrip the physical resources of our country, but we must continue to provide arms to our less industrialized allies while keeping our own national morale high

Hon. Neil H. McElroy

THE real problem in this country is for us to realize that through no desire or action of our own we are the leading nation of the free world. There are two opposing parts of the world. The Communists say that there is no room for both, which to them means that free government must be expelled one way or another from the earth.

Will we—a country which has not been training for this heavy responsibility of leadership of the free world—provide the leadership that will make freedom prevail? My feeling is that we really have no choice. We must do so, and we will.

From the standpoint of national security, what is our position? What is our military position in the world? Is our strength such that our President and our Secretary of State can proceed freely and unhesitatingly in developing and fostering the foreign policy which they consider to be in the best interests of the United States and of the free world as a whole?

DEFENSE and military preparation have only one reason for being, and that is to strengthen the negotiating arm of our diplomatic representatives, starting with the President. Military spending is, in the main, a sterile expenditure of the taxpayers' money. No one gets any benefit out of the shooting of shells in practice except the very important one of protecting the opportunity of our people and of the free world to engage in peaceful competition with the other philosophy that exists in the world.

Mr. McElroy, the former Secretary of Defense, is Chairman of the Board, Procter & Gamble Company, Cincinnati, Ohio. This article is based on an address given recently by Mr. McElroy at the annual dinner meeting of the A.O.A. Cincinnati Post during which he was awarded the Post's Charles L. Harrison Medal.

Thus this conflict which exists, and in my opinion will exist as long as Communism is on the offensive, will have its competition not on the field of military battle but in such areas as economic competition, competition for the minds of men, and other peaceful types of competition.

But there is nothing that is particularly satisfying about spending money for defense except in order to strengthen the position of our President and our diplomatic representatives in the maintenance of peace. They must have an assurance that the strength of their position is backed up by necessary military power, or, of course, they will be disregarded.

Now, where are we? What do we have to offer to our diplomatic representatives?

First of all, we must be—now and always—in a position to deter general war. General war in these times with the type of destructive weapons that we and our opponents in the world have is absolutely unthinkable. It may come, but if it comes neither we and our country nor they and their country will ever again be the same.

So the only thing to do is to retain strength which is adequate to deter any such engagement of military force. This has taken, as it should take, absolutely first priority in defense planning.

THERE was a feeling for quite a period of time that if we didn't match missile for missile of the intercontinental type with the Russians we would be completely out of the competition. This has never been my view. There is in my opinion—and it seems that this view has been confirmed by the events of the last eighteen months or two years—far greater strength in a composite of delivery systems of big weapons than in only one system.

The currently available intercontinental ballistic missiles, like any other first generation of new weapons, were bound to be superseded quickly by much superior second- and third-generation weapons. That is one other reason it was deemed unwise to put tremendous sums of money into first-generation IRBM's. It is a matter, I would estimate, of two or three years at the most before they will be outmoded.

What we have today is a balanced means of delivering large weapons. This is increasingly important as the speed of modern weaponry makes almost incredible demands against a defending nation for speed of reaction. The B-52 bomber, our heavy bomber, greatly exceeding the capability of the Russians, has become a missile-launching platform as well as a bomb-delivery method.

Under most of the B-52's in the future there will be two Hound Dog type missiles, each having a range of 500 miles. The B-52, going in at its target at a distance of 500 miles and outside the range of most of the ground defenses, can launch its missiles and then, with the disorganization of defenses that would come through the use of that kind of distance delivery, the B-52 would follow in and be much more successful with its bomb.

Moreover, the range of the B-52-borne missile is being extended to a very considerable degree—1,500 miles. This is expected within the next couple of years. Hound Dog missiles are on many B-52's today and most of the remaining B-52's will have the equipment within the next several months.

We have a limited capacity with the B-58 bomber—a Mach 2 aircraft with a speed somewhere around 1,200 to 1,400 miles an hour. There is no such bomber in the Communists' possession, so far as we know, and we believe we would know it if they had it. It is a very important factor in complicating the defense problem of the Reds in case retaliatory attack by our forces is necessary.

We are all conscious of the fact that the Polaris submarine is an extremely effective weapon against an enemy who would like very much, in attacking this country, to immobilize through destruction any capability of our own to destroy him.

EACH Polaris submarine is about the size of a cruiser. It carries sixteen missiles which currently have a range of some 1,200 miles and which will be extended at least to 1,500 miles. Imagine having these submarines with their awesome force, around the periphery of the Soviet Union and you get some idea of the repressive effect they would have on any contemplated decision to attack our country.

We have, of course, a gradually increasing number of ICBM's—the Atlas and the Titan—in this country that are being put on launchers, and an increase of the so-called hardened type which are subterranean and therefore much better protected than the first ones put in place.

Coming along within a couple of years is the Minuteman, which is a second-generation missile. Instead of liquid fuel, it has solid fuel, and because it uses solid fuel it can be put on mobile platforms such as railroad cars.

You may have read that the first tremendous radar to detect missile launchings has just gone into operation in Thule, Greenland. It is almost impossible to believe, but these radar screens are the size of three football fields in length. Another one will go in at Clear, Alaska. The two of them, being of such tremendous size, will sweep the horizons to give advance notice of the possible launching of salvos of Soviet missiles, which is the thing, of course, against which we must protect ourselves.

So we have done the kinds of things which in my opinion need to be done to give us a capability to deliver our weapons. We are doing those things and preparing to do others at the time our Joint Chiefs of Staff think we should do them. We are doing those things that keep our delivery systems impervious to enemy attack so we would be in position to destroy an enemy if he did attack us. This is the essential factor in the deterrence of general war.

The other responsibility that we have in this country in the operation of our defense program is to be capable of delivering quickly at any point on the face of the earth an amount of force which hopefully would deter—and if not deter, then snuff out—any limited war. This is the kind of situation we had in Lebanon, and, fortunately, war did not break out. This is the kind of situation we had in Quemoy and, fortunately, there the hostilities were limited to an artillery assault on the island of Quemoy.

Both these trouble spots could have developed into sizable conflagrations of a military nature. The thing that is extremely dangerous in a situation of that sort is that the longer it goes on, the greater the likelihood that the prestige of the major nations in the world may get involved, and if this happens, a limited war quickly becomes a big war with the immense destruction that that means.

If limited conflict threatens, we feel that there is no question of our capability to meet it. This is partly due to the fact that we have mutual security arrangements with many free nations around the world, and we depend on our widespread allies to supply ground forces, and in some cases—as in the very effective defense by the free Chinese pilots against air attack by the Communist Chinese—we also can rely on the air forces of our allies.

WE are also prepared to play our part in limited-war situations with such extremely effective weapons systems as the aircraft carrier and with such units in our forces as the Strategic Army Corps, the Marines, and our Tactical Air Force.

I can assure you that our country is prepared to do what it needs to do in order not only to defend the nation but to participate in the defense of the rest of the free world.

It must always be clear to any world opponent of ours, first, that we have the power to destroy and defeat an attacker, and that we will have this power even if he attacks this country with the incredibly fast and powerful weapons he possesses. And we must at the same time have the will to use that power to protect ourselves and our allies against aggression.

Sometimes this business of having the will to use these forces is something that we take for granted. One of the most seriously disturbing things to our military leaders is the soft kind of reaction that you sometimes get in this country on such a matter as the importance of the islands off Taiwan.

If we begin to yield free-world territory to the Communists there may

well be a chain reaction on the part of those small countries, which are sitting right on the firing line, to the effect that if the United States is not ready to help defend small parts of the free world the smaller countries had better make their peace at any price with their Communist opponents.

LET no one think that the pathway ahead is short or easy. The Communists are willing to wait until the free world lets down its guard. In the meantime, the pressure will be continuous.

Our answers to the Communist challenge must be these—and they must be given over the many years that this competition will continue with the firmness and clarity of free people who are determined to remain free:

First, we must support an adequate defense program for the forces of the United States. The word "adequate" is a word that has been carefully weighed in this context.

There must be no doubt that our defense program is adequate to support the foreign policies of the United States. And there must be a margin of error on the comfortable side. However, once this reasonable margin of error has been provided, any excess above that amount must be regarded as wasteful.

Our country does not have *unlimited* productivity. And our country has many public needs, such as roads, schools, hospitals, and help to the underdeveloped countries of the world. Whatever we may do which is wasteful in any one of these areas, including defense, detracts just that much from our ability to take care of the many other public programs which need doing.

> *"From the standpoint of national security, what is our position? What is our military position in the world? Is our strength such that our President and our Secretary of State can proceed freely and unhesitatingly in developing and fostering the foreign policy which they consider to be in the best interests of the United States and of the free world?"*

Thus I say again: We must continue to plan a long-range program which is *adequate* for the support and equipping of our own forces.

Secondly, we must continue to provide weapons to those of our allies who have the will and the manpower to protect their freedom but cannot provide weapons for that manpower.

The security of the United States in the world is, as a matter of national policy, a collective-security policy in which we rely on our free-world allies just as they rely on us.

Under this concept, the dollars we appropriate for military support of our free-world allies are just as important to our own national security as the dollars we appropriate to our own United States defense program. This has never been clearly understood by the people of the United States, but nothing could be more true.

Thus it must be clear that the continuation of military assistance to our less-industrialized allies will be a necessity for many, many years to come. This is the second keystone to the planning of our national security.

The third requirement that we must place on ourselves is one which is not material but spiritual. We are not warlike. We like to live in peace. We like to trust our international neighbors. It is not an easy thing for us to believe that in this world there are powerful nations which would like to destroy us and will stop at nothing to remove the competition of freedom.

Nevertheless, we must face this. And we must face it with the kind of spiritual fiber which always has been the basis of strength of an informed free people. The race will be long, but to lose is unthinkable because to lose is to lose our freedom.

IN this campaign of a materialistic ideology against a group of free nations which believe in the importance of the individual and in the spiritual leadership and protection of God, we have the strength to win—and *we will win.*

The 500-mile-range Hound Dog is now standard equipment on B-52 "missile platform" bombers (U.S.A.F. photo).

New Army Weapons

The Army's new 47,000-pound T196E1 self-propelled 155-mm. howitzer, above, uses 19,000 pounds of aluminum in hull, turret, and other components, which gives it increased range and mobility. The Army's new 40-mm. grenade launcher, below, which will fill the gap between the hand grenade and the mortar, has an aluminum barrel and weighs only 6 pounds (Army photo).

Our Future in Space

The new age upon which we are entering offers many challenges to our scientists, engineers, and industrial leaders in developing the required weapons, vehicles, and manufacturing procedures

Dr. H. Guyford Stever

THE technology of the new field of space is unfolding rapidly. Astronautics or space flight or space technology, whatever you call it, has become big business. In the last fiscal year the expenditures in this country alone were about $4 billion, if one includes about $2 billion in research, development, and testing, and almost $2 billion in operations, mostly military.

As a big business it is not an old one. To laymen it seemed to burst upon the world with great suddenness three years ago, and the very suddenness of its realization brought its greatest effect on the people of this country. It awakened the people of the United States to something that some of us had been trying to tell them for a long time—namely that the Communist world was using its advance in science and technology more profitably in the military field than we were.

THIS theme was not new. During the previous decade we had received several jolts about Russian technical capabilities, but we had ignored them. Their adoption of the turbojet engine for their high-speed fighters, their development of an atomic-bomb capability in four years—a much shorter time than was estimated by our scientists—their long-range turboprop and turbojet commercial airline and bomber aircraft developments, and a number of other demonstrations had given us an indication that their technological strength as applied to military problems was growing faster than ours.

Dr. Stever is professor of aeronautical engineering at Massachusetts Institute of Technology, Cambridge, Mass. *This article is based on an address given by Dr. Stever before a joint meeting of the A.O.A. Cleveland Post and the Missiles and Astronautics Division held in Cleveland at which Dr. Stever was awarded the Scott Gold Medal.*

Science in the Communist countries was also of high quality. Their technological progress was not based, as many of our people wanted to believe, on superficial and insufficient scientific progress. The emphasis the Communists put on education, particularly in the scientific and technological fields, was growing apace, and it was of reasonable quality.

In the many fields of technology which are required for practical space operations, propulsion has been the key field. The development of high-performance rocket engines was the key which enabled us to bring to reality the ancient dreams of space flight. Rockets are quite old—Chinese literature mentions rockets in military operations almost a thousand years ago. They appear from time to time in our military history—such as at Fort McHenry to inspire Francis Scott Key in his composition of "The Star Spangled Banner."

But it was the high-performance liquid-propellant rockets—first flown at Auburn, Mass., in 1926 by Dr. Robert Hutchins Goddard, then developed in Germany in preparation for World War II's ballistic attacks, and further developed by Russia and the United States for ballistic missiles—that has given us the capability to establish satellites of the earth or to escape the earth's primary gravitation to become satellites of the sun or other planets.

AT the time the space field was brought so dramatically to the attention of the American people and the American leaders, our ballistic-missile programs were well advanced. Even though this was true, the pioneers in that field had had difficult times getting support. The leaders of this country, most advanced technologically in the world, had consistently failed to realize that technological change is rapid and must be accompanied by similar changes in governmental activity.

Today, however, everyone accepts space technology as a key technology behind our military strength. The number of important military applications of space technology increases almost daily. Each of our military services has an important role in these developments, and each is settling down to some important tasks in space.

But the abrupt advent of the space age didn't just awaken us militarily—it awakened us in many other important ways. In education, for example, though the awakening started in the field of engineering and science, I have noted that there has been a revival in learning in all fields, partly due to the higher competition that's offered by engineering and science but also partly due to the more challenging times that space is bringing.

But not only has there been a renaissance of interest in science, technology, and education—other fields have felt the resurgence, too. In literature there has been a great increase in reading of all kinds of material.

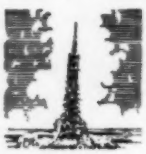
Certainly in the field of political science the advent of the space age has faced individuals and organizations, private and governmental, with a large number of problems. The urgency of arranging for more effective peace guarantees has become more intense. The combinations of nuclear bombs, with ballistic missiles and space craft to deliver them, has put the pressure on our statesmen and political scientists as it never before existed. I hope they respond.

For military reasons alone a vast space activity could be justified, and I think that this country has made a mistake, in its desire to appear as a peace-loving nation in the eyes of the rest of the world, in playing down the importance of space development in our military operations. Still, there is much of importance in the nonmilitary side of space activities.

MUCH has been said about the reasons why we, a country of practical people, are interested in space flight. In the early days of the balloon and airplane, many developments came from private resources. In space technology, however, the last significant personal investment was that of Harry Guggenheim and the support of Dr. Goddard. All the rest of the developments have been supported by funds from the public till. In getting support today, anyone who gives as his motivation personal adventure or the "because-it's-there" answer of George Leigh Mallory when asked why he wanted to climb Mt. Everest, can expect little support. He must have an answer about how his space venture will improve the commonweal.

Still there are elements, important and expensive elements, of our space program which at this stage can be thought of in terms purely of exploration. In this category are the manned space flight efforts, beginning with Project Mercury and followed by the manned exploration of the moon. Also we must include in exploration those unmanned probes to be shot to our nearer planets of Venus and Mars.

Personally, I think this space activity is entirely justified. Many great leading nations of the past have challenged men's minds by support of new explorations and discoveries. If we are to lead in the future, so must we.



Scientific research certainly is benefiting from space activity. Actually, I think, pure scientific research in recent decades has been receiving help from space activities rather than furnishing great help to them. In recent decades space has been primarily the field of engineers and technologists who have been applying older sciences to this activity of man.

A great tribute should be paid to the rapidity with which industrial engineers, trained in older technologies, converted their fields to space. In doing so, these engineers have paid part of their debt to earlier science by providing vehicles and techniques to the modern scientist to conduct even further research.

Those of us who spend all or part of our lives in military technology—who believe that in creating our country's military strength we are actually defending some of the better things in life but, on the other hand, have a feeling that nonmilitary technology may be more satisfying to our inner selves—have always pointed out that technological developments made for military purposes usually work into the nonmilitary technological life of men.

One of the most outstanding examples of this in the past has been the development of the aircraft, largely financed in its advanced forms by military developmental money, which now is the most potent force for the transportation of people in the world. Space developments will parallel this. The applications of the space field to our everyday lives are already becoming evident, even though as a business it is only a few years old. Commercial companies are beginning their own activities in the field of space communications for civilian purposes—activities which, though they may have started by government support, are now on the threshold of normal commercial exploitation. Other fields that will follow, I am sure, are mapping, weather prediction and analysis, and, eventually, transportation.

Finally, it is most important to see how space has affected the defense industry. In the first place, the nature of a large amount of military-industrial work has changed quite considerably. Production lines in many fields are not of much importance. The force which is necessary to create an obliterating threat to an enemy requires small numbers of weapons which don't lend themselves to mass production.

THE production worker is no longer the key person in this business. More and more the work is being done by engineers. The percentage of engineering which goes into new weapons or peaceful space vehicles has radically increased, and, at the same time, the number of like items produced has been greatly reduced.

Many people speak of the challenges of the Space Age and refer to the challenges posed for scientists, engineers, astronauts, students, and military planners. There is an even more significant challenge presented to industrial management and government leaders who through contractual arrangements so greatly affect industry. This is the challenge to convert our space-oriented industry from the old production-based-profit type to the new engineering-based-profit type.

I don't think this challenge has been met, but it must be if we are to remain as strong in space as our potential enemies, for we can't remain strong without having our great industries as participants in the space program.

Spanish Infantry Weapons

Armed with the excellent CETME automatic rifle backed by effective supporting weapons, the Spanish foot soldier is one of the finest in the world and assures the military strength of our "total ally"

Jac Weller

IF we had to fight another Korea, we probably would be aided by more soldiers from Spain than from any other nation. Even though not a member of NATO, Spain is our total ally for Spanish hatred of Communism in all its forms stems from their own Civil War experience. During that conflict the Russians, and even the Spanish Communists, behaved like beasts.

A few years ago Spain felt isolated and friendless. The Communist world was actively hostile, and many other nations were distrustful. Surrounded by potential enemies, Spanish military plans were essentially to hold the Pyrenees and their seacoasts to the death. The friendship of the United States, and to a lesser extent that of West Germany and other NATO countries, has changed this. They are not alone any more, and Spain is again willing to think of the international picture and join with other anti-Communist nations in protecting freedom everywhere.

The Spanish infantry was the best in the world in the sixteenth century. In their Civil War they showed a bravery, steadfastness, and finally a simple efficiency that hasn't been excelled in the twentieth. With American assistance, the Spanish divisions can be of great value to the West.

Spain was kept out of the United Nations until 1955, and the country still isn't a member of NATO. However, Spain and the United States signed an agreement for mutual aid in 1953 which has progressed steadily. We have sea and air bases and radar stations; Spain has U. S. heavy equipment of all types. More important still, we are friends.

Mr. Weller, a well-known authority on small arms, is also a student of foreign armament. His article on the West German Army appeared in the November-December 1960 issue of ORDNANCE.

Spaniards trained in the U. S. service schools frequently do better than any other foreign students or even our own, and they are well liked. Our personnel over there could not possibly feel more welcome in a foreign country.

Over the years, Spain has changed from the original Falangist government. The Cortes, or Spanish Parliament, was reestablished in 1942, and there is a Regency Council to take over if Franco should be incapacitated. In 1957, a long-range plan to form a closely controlled monarchy and with a premier of the democratic type was started. The next year, Franco pledged that the government would become by easy stages not only traditional, representative, and Catholic, but social (welfare-minded) as well.

Spain is not yet a democracy; there is more individual freedom, however, than in some nations which claim that distinction. All Spaniards have been able to return to their homeland for many years regardless of which side they took in the Civil War. Many officers presently in the Spanish Army fought against Franco. If someone wants to speak ill of him or any one else, he won't land in jail or lose his job.

SPAIN at this stage of its national evolution probably couldn't be a democracy—as a republic it degenerated quickly into a Communist chaos. But most Spaniards and their real friends like what they have now and have confidence in the future.

The political transition is complicated, however, by the dispatch from Russia and her satellites of well-trained agents and lots of money to create unrest in Spain and an atmosphere where complete political freedom would be against the best interests of the country as a whole. So far, these Communist efforts seem to have failed completely, and the Spanish government, economy, and way of life are more firmly established than at any time within the last two centuries.

The nation has a population of nearly thirty million people. They have national traditions and military prestige of a high order. They lost more than a million men killed in their terrible

Civil War, but their senior officers and NCO's know more of actual infantry fighting than in any other nation save perhaps West Germany. The present military establishment has received preferential treatment, and a third of the annual national expenditure goes for the army, navy, and air force—mostly for the army.

Spain is a comparatively poor nation economically. Neither the total tax revenue, nor the average standard of living is as high as in Britain or West Germany. The economy, along certain lines, however, is strong. The manufacture of Spanish small arms and infantry-supporting weapons is flourishing. Don't be confused by the junk made in Spain between the World Wars for cheap civilian sale abroad. The new Hispano-Suiza 20-mm. automatic cannon presently made for West Germany, as well as other modern military arms, is first rate both in design and execution.

THE most valuable Spanish contribution to the free world, however, is the army with approximately twenty predominantly infantry divisions which could be fully mobilized and ready to go in a matter of hours. This army has modern armor, heavy artillery, and tactical aircraft, but in supporting quantities only. At present it has no atomic potential. But Koreas are fought by supported infantry, and Spain and the United States would complement each other in one of those.

In contemplating a more terrible type of war, our common enemies must consider the vast distances and rugged topography of the Iberian Peninsula which is perfect for certain types of bases, but practically unassailable. Spain, the U. S., and our common ally, Portugal, can create here not only a fortress, but a deterrent of the first magnitude. We would supply the sophisticated weapons; they the necessary rugged infantry.

There are four mountain divisions in the Spanish establishment. These are composed of two brigades of three battalions each and are principally deployed along the Pyrenees. No real effort has been made to mechanize these forces, and they are still largely equipped with animal transport which, even though outdated, is most efficient in this terrain. Supporting weapons are fitted to the theater of probable use.

The other divisions are presently organized for service anywhere. Each consists of five battle groups plus armor, artillery, and service elements. A battle group consists of a headquarters company of 78 men, a support weapons company of 112 men, and four infantry companies of 247 men each. The battle group support company has four 90-mm. self-propelled artillery pieces. These are now usually U. S. M47 tanks, but these will be replaced by lighter, more maneuverable self-propelled guns of the same power. This unit has also six modern, Spanish-made 120-mm. heavy mortars.

Each infantry company, which because of its size in the Spanish Army is commanded by a major, consists of a headquarters section of 36 men, a weapons platoon of 31 men, and 4 rifle platoons of 45 men each. The weapons platoon has three 81-mm. mortars and two U. S. 106-mm. recoilless rifles.

A rifle platoon consists of a support-weapons squad of nine men and three rifle squads of eleven men each. The support-weapons squad is equipped with two medium machine guns with tripod mounts and two 3.5-inch Spanish rocket launchers which can use U. S. ammunition if necessary. Each rifle squad has either eleven CETME rifles, or ten bolt rifles and a heavy automatic rifle. Four divisions are presently equipped with CETME's which will replace all other infantry rifles.

THE Spanish small-arms situation at the end of their Civil War was chaotic. There were Russian, Mexican, Italian, German, and French arms in quantity, as well as, of course, the old Spanish family of weapons. There were even a few of U. S. and British models. All weapons not firing either the 7.92-mm. Mauser rifle and machine-gun cartridge or the 9-mm. Luger pistol and submachine gun cartridge were scrapped or stored. This standardization was carried out ruthlessly, even though it met with some opposition and meant the retirement of the Spanish 7-mm. Mausers.

The German short Mauser rifle, sometimes called the model 98-37, was the standard Spanish infantry arm from 1939 to 1957. These rifles are still the most numerous type in the hands of the Spanish Army but are now all Spanish-made. Infantry squads armed with bolt rifles needed a heavy automatic rifle or bipod-mounted machine gun to give them additional firepower. Spain used several of these. The Czech

CETME rifle variations with magazines and ammunition.

Spanish-designed and -made infantry vehicle with 81-mm. mortar.

ZB26, the same weapon which became the British Bren, was the most numerous at one time. However, when made in Spain and slightly modified it became the FAO (Fabrica de Armas de Ovied). The German MG-42 with bipod mounting also was used.

THE CETME rifle replaces both rifles and automatic rifles at the squad level. This rifle was designed by a Spanish team containing some formerly German ordnance engineers—the name CETME comes from Centro de Estudios Tecnicos de Materiales Especiales. It appears to be gas-operated, but is in reality a cunningly delayed blowback. This weapon has recently been selected for exclusive future issue in Germany also. It is a very good rifle indeed.

The CETME follows the best modern principles of design. It is simple and easy to make, and as now modified it is rugged and functions well under all conditions. The barrel is located well below the line of sight so that the recoil is straight back into the shoulder of the firer, rather than above it which would, of course, lead to a rise of the muzzle in full-automatic operation. The weapon presently fires both single shots and bursts from a closed bolt, even though an earlier model left the bolt open in full-automatic operation.

There are two models—one weighs just a trifle under ten pounds, and the other slightly more than twelve—and both have folding bipods. Weight is necessary if a weapon is going to fire accurately in bursts. All models have a selector which allows the soldier to fire full-automatic. The cyclic rate is slightly less than 600 rounds a minute.

Even though the production of CETME's is up to schedule, all units won't have them for some time. In the interim, CETME-equipped units will require 7.62-mm. NATO ammunition while other units would still need 7.92 Mauser catridges. Spain has started on a plan that will considerably shorten this 2-ammunition period without greatly increasing cost. Old 7-mm. Spanish Mausers are being taken from storage, rebored, rerifled, and rechambered to 7.62 NATO. The FAO (Model 59) again has been slightly redesigned to handle the NATO ammunition.

When the Spanish infantry was predominantly armed with bolt-action rifles, the submachine gun was of considerable tactical importance. Some officers with long experience in the Civil War felt that, in spite of its lack of long-range power, infantry units would sometimes have been more effective if they were completely equipped with submachine guns. Much of the Civil War fighting took place either at long range where only machine guns were effective, or at such short range that submachine guns had advantages over bolt rifles. By the end of the war, many units had about half rifles and half smg's. The CETME, however, decreases considerably the need for another full-automatic arm.

In 1957, the Parinco III submachine gun had just been adopted. This was a very fine weapon, indeed, which could be fired accurately not only for single shots but also for long bursts. The weapon was simple, reasonably light, and had a realistically low cyclic rate of fire. It was compact and trouble-free. The plan was to supply it in sufficient quantities so that within a relatively short time all submachine guns in the regular army would be of this type.

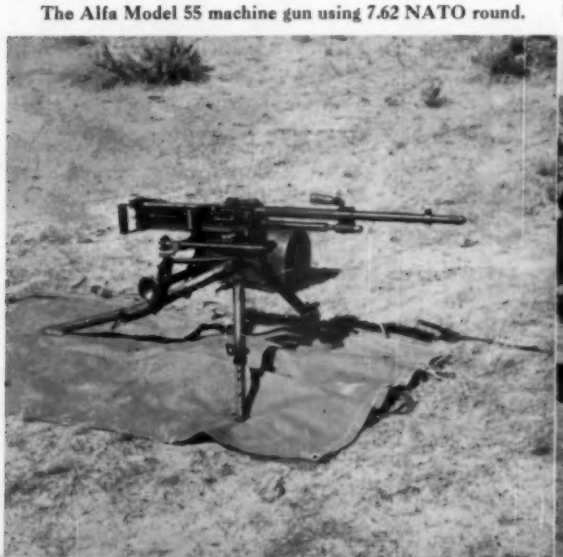
This idea, however, has been changed with the introduction of the CETME. A lot fewer submachine guns will now be necessary. The general plan seems to be to continue the older smg's, including the Super Star Model 1945. The latter weapon is Spanish-made, but follows the Schmeisser design fairly closely. It's probable that when the CETME replacement has reached a certain point, the Parinco III will become universal in the Spanish Army.

The army machine gun is a heavy weapon fired from a tripod. Spanish Civil War experience indicated that weapons of this type functioned better than lighter intermediate (or medium) machine guns. The Spanish Alfa weighs complete 82.5 pounds and is first rate. The Model 44 fires the 7.92 Mauser and the model 55 the 7.62 NATO round but otherwise are almost identical. The later model has, however, a lighter tripod.

Whereas the Alfa is standard and most numerous, there are other machine guns in the Spanish Army in addition to the MG-42's already mentioned. The heavy Czech Z.B. 37, weight complete 92.4 pounds, has two rates of fire and horizontal handles with thumb trigger.

The ordnance of the Spanish infantry somewhat limits its tactics. The replacing of both bolt rifles, the old BAR-type automatic rifles, and many submachine guns with CETME's is a radical change. Every infantryman

The Alfa Model 55 machine gun using 7.62 NATO round. **U. S.-made 106-mm. recoilless rifle, part of each weapons platoon.**



Officers and men watch new recruits fire CETME rifles during training.

now can serve as a light machine gunner, but the Spanish officers have some fears that ammunition consumption could be too high.

On the other hand, the responsibility for firing which always was present in the mind of the automatic rifleman of the old squad may be lacking, and the new arms could lead to less, rather than more, firing. Even if used, the CETME just possibly might be too light for acceptable accuracy in full-automatic bursts under battlefield conditions.

FROM my personal observations I would not expect these two troubles to occur. However, if either should, the new FAO 22-pound automatic rifle is available and could be issued quickly. It would be "crew served" in spirit and solve the accuracy problem also.

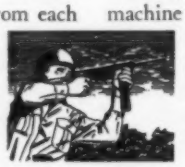
As an alternative to the standard issue of the FAO's in infantry squads, they might be kept in reserve and used only where circumstances were favorable, as the Germans do with their MG-42's.

The Spanish infantry-supporting weapons are adequate and manueuverable. Riflemen are carried in vehicles only for longer distances, but the heavy infantry arms are motorized. The 106-mm. recoilless rifles are mounted on U. S. jeeps. The mortars are taken in Spanish-designed and -produced cross-country trucks.

The offensive tactics of the infantry were perhaps best illustrated by a battle-group tactical exercise put on for a number of interested observers from both the Spanish Army and friendly countries. The supposed situation was that the Spanish unit was advancing, but not yet in actual contact, with a stationary enemy force whose security line (old skirmish or picket line) extended east and west from our observation point and was represented by a few targets.

The enemy main or battle line was located some 600 yards to the north and also was represented by silhouette targets and sandbag positions simulating supporting weapons. The advance of the Spanish battle group from the south was on a front of about a mile and a half. Two infantry companies were abreast with one in reserve and one in support. The supporting weapons company was in two sections roughly abreast of the rear infantry company.

Each of the leading rifle companies had two rifle platoons leading with one in support and one in reserve. The motorized weapons platoon was well to the rear. The first we saw of the Spanish force was a thin reconnaissance line composed of a single squad from each of the four advancing platoons. In other words, there were approximately forty-four men in an irregular line a mile and a half long. It was impossible to see them all at any given time on the irregular terrain.



When still about 400 yards from the enemy security line, the nearest Spanish squad began to fire. Someone in it presumably had seen an "enemy" silhouette target. Operated by remote control, an "enemy" machine gun firing blanks opened up, theoretically pinning down the Spanish skirmish line. However, the four rifle platoons moved up quickly into line with their advance squads. Fire became heavier as they moved forward using live rounds and trying to score as many hits as possible on the first group of silhouette targets.

The heavy full-automatic fire from more than 150 CETME's was soon reenforced by the 8 machine guns and the 8 bazookas from the 4 weapons squads organic within the platoons. This drove the "enemy" security line in; their main position was now uncovered and revealed itself by some simulated return fire.

The major commanding the closest Spanish company was with the observers and explained the situation. He received orders by radiotelephone from the battle-group commander to begin an attack in concert with the other advanced company to the east. He explained how he was planning to use his supporting weapons. He sent one of his 106-mm. recoilless rifles to the right and the other to the left. He kept his three 81-mm. mortars together and positioned them on the reverse slope of a hill 600 yards behind his front, about 1,200 yards from the enemy.

The company commander gave orders over his radiotelephone for the supporting fire to begin. Seconds later there was the familiar whoom, whoom, whoom of the 81-mm. mortars dropping shells on the enemy line. There were sudden blasts from the recoilless rifles. One of these scored a direct hit on a strongpoint and sent sandbags flying.

The infantry platoons began to advance again with their support squad machine guns chattering. The bazookas sounded off. Every one of the simulated "enemy" crew-served weapons positions was located and blown up.

As the infantry approached the silhouette targets, the platoon commanders were keeping their men in fairly regular formation and roughly abreast. The last phase of even a practice Spanish infantry attack can be rather dangerous, and they didn't want any casualties in this demonstration. The support-weapons fire was now masked. Suddenly, the left center platoon seemed to rise in unison and make a sweeping motion with their arms. About three seconds later, there was a line of explosions among the targets. They had thrown grenades. The other three platoons did the same. A second grenade was thrown by all men. Then came the final charge.

We had seem the type of attack that would be made by a Spanish battle group if not supported by tanks and heavy artillery. In actual practice, there would have been at the very least the battle group support 90-mm. guns and 120-mm. mortars. But the guns have a nasty habit of sending ricochets for miles and the big mortars not only cost a lot of money to fire but also send lethal shell fragments in all directions.

We now had a question-and-answer period. I was particularly interested in getting the Spanish opinion as to the value of the CETME rifle for close action in comparison with the old submachine guns. I was assured that the additional power of the 7.62 NATO cartridge over that of the 9-mm. Luger more than made up for the greater ease of controlling the fire of the submachine gun.

THE Spanish infantry feels that full-automatic fire from the CETME can be useful even from positions other than prone. There are still forty-eight submachine guns in a Spanish infantry company, but they are issued mainly because the weapons are more easily carried about by soldiers not primarily expected to take part in fire fights with personal arms.

Spanish infantry defensive tactics were explained in this same discussion period. Perhaps unconsciously, the Spanish officers had arranged the "enemy" in the demonstration just concluded in the type of defense they would have used themselves. Spanish infantry will employ a weakly held security line with a main front line some distance back. The machine guns and bazookas will be placed where fields of fire appear to be best. Lateral fire with machine guns is not quite so important as in the German Army.

The recoilless rifles are a problem in defensive situations. One shot and their position is revealed to every enemy observer for miles. Where possible, some cover will be chosen so that they will be no more obvious than necessary. These weapons have extreme power and accuracy, but if their position cannot be changed quickly after the first discharge, they are almost certainly lost.

The 81-mm. company mortars will be located as terrain dictates, but far enough forward so as to bring under fire the staging areas for an enemy attack. The battle group mortars need not be so far forward because of their greater range.

The Spanish Army is composed of about twenty-five per cent regular or career soldiers. The remainder is made up of required service personnel; both are efficient. A Spanish recruit undergoes a rigorous three months of basic training and is then sent to his unit. He could give a good account of himself on the day he joins it, if he had to. The Civil War certainly proved this. However, other things being equal, a soldier is more efficient and less casualty-prone with experience and further training.

The regular enlisted army in Spain as elsewhere is composed of a cadre of NCO's for training and organization plus additional specialists. Some few crack units are composed mainly of regulars. Because of economic conditions and army prestige in Spain, posts in the regular army are more attractive and sought after to a greater extent than in most other countries. The pay does not seem high by American standards, but compares favorably with similar civilian employment. A soldier in Spain is envied by many civilians; he is a hero, though he may never have heard a shot fired in anger.

The Spanish officer corps is composed entirely of regulars. All new officers today are graduates of the Spanish Military Academy or have been promoted from the ranks. The present regime has abolished the right to a commission that the top socioeconomic families had at one time. Admission to the academy is open to all who pass the required examinations which include not only academic proficiency but physical ability and stamina and certain qualities of leadership.

There is a continuity of military service in many families, however, since Spanish officers provide their sons with the type of schooling needed to pass the examinations. Further, they train their boys physically and in leadership. Both in pay and in social position, a Spanish army officer may be considered fortunate.

THE regular enlisted personnel and officers not only train the young men who report to them well, but quickly inject into their souls a pride and desire to do well that is most pleasant to see. Not all recruits have graduated from the equivalent of high school or even junior high, but they are lean, capable, brave, and tough.

Most Americans like the Spanish Army, though it has some shortcomings as do all armies. In Spain, the science of logistics is not so well understood as elsewhere. Supply problems are not always quickly solved, particularly in regard to nonessentials. However, in basic military values the Spanish Army scores, in my opinion, very high indeed. It is well armed, organized, and led and has abundant practical experience in the kind of fighting it probably will be called on to do.

As I looked around at the faces of the lean, hard Spanish infantry officers, I could not help but feel a real confidence in them. They beat the Russians once when they came to Spain. They are sure they can do it again.

Spanish-designed and -made 3.5-in. bazooka considered superior to U. S. weapon.

Civil War Ordnance—IV

Guns for the Navy

Rear Adm. John A. Dahlgren altered the art of sea warfare with his invention of the boat howitzer and large-caliber shipboard cannon

W. T. Adams

OF the many men who contributed to advances in ordnance and gunnery by the American Navy one stands out above all others for the lasting effect of his work. Called by some the father of American naval ordnance, John Adolphus Bernard Dahlgren earned the title not merely for developing the guns of the Civil War Union Navy, but primarily for the manner in which he forged the Navy's spirit of scientific approach to the problems of ordnance and gunnery.

While Dahlgren's lasting fame rests on his ordnance achievements, his accomplishments in command of the Union blockading fleet at Charleston cannot be ignored. Having been promoted to captain in 1862, he was made a rear admiral in 1863 and given command of the Charleston blockade fleet. Here his drive and initiative were major factors in making success of an operation that had only limped along under his predecessor.

Born in Philadelphia on November 13, 1809 (where his father served as Swedish consul), Dahlgren frequently visited the Philadelphia Navy Yard and developed an early interest in the sea. The naval vessels being built and repaired at the yard fascinated the young man, and as soon as he was of age he applied for a berth as midshipman in the Navy.

When his first application for appointment was rejected, young Dahlgren decided to sail before the mast in a merchantman in order to obtain seagoing experience, and when he received the coveted appointment as acting midshipman in 1826 he was already an experienced seaman.

Mr. Adams, a well-known student of military history, lives in New Orleans, La.

Dahlgren's first Navy assignment aboard the U.S.S. MACEDONIAN, and his next aboard the U.S.S. ONTARIO, were marked by little of significance. The turning point in Midshipman Dahlgren's career, although he little realized it at the time, came with his assignment to coast survey duty in 1834. It was this duty that first brought him into contact with the practical use of mathematics, and he soon demonstrated a singular aptitude for the work. Within a short time Dahlgren became second assistant in the survey party, applied himself to his work assiduously, and in March of 1837 was appointed to the rank of lieutenant.

Unfortunately, his mental capacity for work was not equaled by his physical capabilities, and after some three years of survey work his eyes had suffered to such an extent that he was almost blind. Unable to perform military service, Dahlgren was released from active duty and attempted to cure his eyes by rest. For nearly six years he was threatened by complete blindness and then, remarkably, his eyesight began to improve. In 1843 he returned to active duty.

After a Mediterranean duty tour aboard the U.S.S. CUMBERLAND, Dahlgren was assigned to the Bureau of Ordnance and given the task of improving the Hale rockets. Unfortunately, however, no ordnance establishment existed for the Navy, and manufacture of the rockets in any usable quantity was entirely impractical without provisions for a separate factory.

After a brief study, Dahlgren proposed the establishment of an ordnance workshop at the Washington Navy Yard, and his suggestion was soon adopted. With the workshop, of course, came the need for proper tools and then, logically, a firing range. Slowly, but ever so surely, Lieutenant Dahlgren was shaping the course of the Washington Navy Yard toward its eventual destiny as the Naval Gun Factory—finally known as the Naval Weapons Plant.

THE ordnance assignment was ideal for a man of Dahlgren's capabilities. It provided him with an opportunity to probe into the problems that plagued naval ordnance of that day, and his solutions affected virtually every phase of naval warfare. His ideas were many and varied—a new type bayonet for Navy rifles, a new type of primer, a rifled musket, a new type of spring percussion lock, and many other valuable ordnance items.

One of his major developments during this period was a howitzer for use on small boats. As with most new and unusual ideas, his first proposals met with considerable official objection. Casting a gun in an old brass furnace, however, Dahlgren successfully completed a

bronze howitzer of his own design that weighed only 220 pounds. The weapon was such a complete success in service during the Mexican War that production could not meet the demand, and Dahlgren's howitzer marked the beginning of practical small-boat armament.

The howitzers became a standard American naval weapon, and Dahlgren explained their operation in "The System of Boat Armament in the United States Navy" which he published in 1851. Both the howitzers themselves and Dahlgren's book received wide acclaim throughout the world, and the weapons saw service in every corner of the globe. Commodore Foote used them in 1857 in his attack on the Chinese barrier forts and particularly praised them in his report of the action.

During the Civil War they were used extensively on the rivers and in landing expeditions and several were even mounted in the tops of Farragut's squadron when he ran the batteries on the Mississippi River.

A second major development resulted from Lieutenant Dahlgren's realization of the need for more destructive weapons for the Navy. Logically, of course, this demanded heavier shells, which in turn meant a heavier propellent charge. Any gun of standard design, if built to withstand the powder charge that Dahlgren desired to use, would have been so large and unwieldy as to have been completely useless aboard ship.

Recognizing this, Dahlgren approached the problem scientifically and proceeded to enlarge the gun greatly at the breech while tapering the barrel appropriately so that it would withstand the diminishing pressures encountered in the bore. The Dahlgren gun, as it was called, was a radical change from standard naval design and, as might be expected, met determined opposition.

MANY officers believed quite sincerely that the new guns would be unmanageable in a seaway due to their size and weight, but such ideas held little import for Dahlgren. He continued his design and experimental work and constructed 9-inch, 11-inch, and 15-inch guns.

His tests convinced Dahlgren, if not others, that use of such guns was entirely practical, and he urged the building of screw frigates to be armed with 9- and 10-inch guns of his design. The plea fell on deaf ears, however. Dahlgren had begun to point the way toward the advantages of increasing offensive power by employing ordnance of the largest practical size—but it would be many years before his theory was accepted.

In the meantime, in addition to his design work, Dahlgren continued to supervise the work of the ordnance department of the Navy Yard and was responsible for many improvements, including a new ordnance plant with gun foundry, machine shops, and associated facilities.

In 1855, at the age of 46, Dahlgren

was finally promoted from lieutenant to commander. The following year he published his work on "Shells and Shell Guns," which was received with wide acclaim in both the United States and Europe. Of more importance, however, the U.S.S. MERRIMAC, commissioned in 1856, was the first vessel to be armed with the 9-inch Dahlgren guns.

Despite the forebodings of many experienced officers, these guns were a complete success in their trials and proved to be entirely manageable while exceeding all expectations for range and accuracy.

Belatedly recognizing Dahlgren's ordnance genius, the Navy Department gave him command of a sloop of war, the U.S.S. PLYMOUTH, to arm as he desired for a thorough test of his ordnance ideas. Bringing the vessel to the Washington Navy Yard, Dahlgren proceeded to equip her with one 11-inch and four 9-inch Dahlgrens in addition to three of his howitzers. The PLYMOUTH was then taken on a 6-month cruise during which gun drills were held daily to test the feasibility of handling the heavy guns at sea. Once again Dahlgren's fondest hopes were exceeded.

The Secretary of the Navy's annual report in 1857 advised that "The PLYMOUTH encountered long-continued boisterous weather on her return homeward, with some heavy gales, during which the heaviest of her cannons were secured perfectly with ordinary lashings, and were as well under control in a rough sea, when cast loose for practice, as could be desired."

In 1861, as the Nation tottered on the brink of Civil War, Dahlgren was serving as second in command of the Washington Navy Yard. Capt. Franklin Buchanan, then in command, resigned to join his native Southland, and Dahlgren was given temporary command of the Yard.

Washington was in a troubled state, and the very security of the Nation's Capital was doubtful at times. Through it all, however, Dahlgren's development of defenses for the Navy Yard was vigorous and resourceful, and it appears likely that it was this spirited approach that brought him to the attention of President Lincoln.

In any event, a close friendship soon developed between Commander Dahlgren and President Lincoln, and it has been said that no officer of the Navy enjoyed a greater intimacy with the President. Exactly how much Dahlgren may have influenced Lincoln throughout the war probably never will be known—but his position as a friend and adviser to the President is clear.

LINCOLN often appeared unannounced at Dahlgren's Navy Yard office, and Dahlgren himself was a frequent and informal White House visitor. Lincoln's personal interest in weapons resulted in many a discussion between the two men relative to the merits of new developments, and numerous inventors were referred to Dahlgren by the President for evaluation of their ideas.

After the Civil War, Dahlgren's career was anticlimactic. He commanded the South Pacific Squadron for two years, then returned to Washington as Chief of the Bureau of Ordnance in 1868. An administrative assignment was little to his liking, however, and within a year he had again become commanding officer of the Washington Navy Yard. It was there, in the midst of continued work and experiments, that Rear Adm. John A. Dahlgren died on July 12, 1870.

New Shapes in the Sky

The Grumman W2F-1 Hawkeye, above, the Navy's newest airborne scout airplane, is designed to give early warning of an enemy attack and to direct intercepting aircraft. The new Boeing-Vertol 107 twin-turbine helicopter, below, is designed to be used by all the military services and can carry 26 to 30 passengers or troops and cruise at more than 155 m.p.h.

Defense Highlights: Monthly Review and Outlook

• **Reorganization Again Rears Its Head.**—The Defense Department—the great empire that governs the military services—is undoubtedly due for some shaking up under the new Administration with the end result anxiously watched by the generals and admirals who get the blame when military operations fail and by industry which is concerned that excessive restrictions may complicate its contribution to the Nation's defense.

Study groups are springing up in quantity. One, headed by a congressman, aided mostly by lawyers, was reputed to say that the present "Pentagon organization" is based on World War II weapons and does not want to consider jet long-range bombers and fixed and movable missile bases. It is difficult to believe such a statement since the defense budget shows the vast sums now appropriated for those particular items.

Anyone who would take the trouble to read over the hearings before the last sessions of congressional defense appropriation committees will see that our military leaders are not neglecting the weapons of mass destruction but are deeply concerned over our shortages in conventional tools of war—mobile, well-armed land forces, adequate tactical and transport aircraft, and multiple sea forces.

They keenly desire more of the fabulous technical advances, the great weapons that are so expensive, but also note that over the past fourteen years the Communists have run off with a large amount of territory using only rifles and tanks (and agents!).

In any event, these lawyers are convinced that there should be more unified commands and that the Secretary of Defense should have more authority and should reduce the "coordinators" and boards that stagnate decisions.

Another group, entitled the President's Commission on National Goals, covered every conceivable general field of human interest (approximately seventeen) in its report to President Eisenhower. To be appreciated the report should be appraised on the basis of the commission's personnel *and* their dissenting remarks. It is an amazing document that all citizens should read as it may guide the incoming Administration.

In the defense area, for example, "through bold and tough-minded management we should reduce lead time in bringing new weapons to operational use." Yet this document proposes so many things the Federal Government should support and requiring increased taxes that "management" will be hard-pressed to be "bold and tough-minded" when it is faced with the bill!

The year 1961 should be a fascinating time that might even produce a commission to study "Why the U.S.A. Should Be Aggressive Instead of Defensive."

• **Force and Counterforce.**—Counterforce is the new word in the air-space-atomic argument. We must have enough strategic bomber and ICBM power to smother everything an enemy could use against us, especially his missile bases. This seems quite difficult since it is problematical where the missile bases of certain unfriendly nations are located—they have an iron curtain and we have stopped flying U-2's.

The counter-counterforce proponents believe that the threat of blasting an enemy's industrial centers is adequate to deter him from striking us; therefore we need more limited-war forces. They have a very good argument since no one has yet used his deterrent force while the Communist-controlled area continues to grow larger.

In all this there is a slight reversal since, according to the Douhet theory of earlier air-power proponents, one could quickly dominate a country by destroying its industrial centers.

• **Missile Base Construction.**—ICBM missile base construction is recovering from early delays under the new management teams established by the Air Force and the Army Corps of Engineers as reported in ORDNANCE for September-October. The engineers expect to complete, as programmed, 270 launchers for Atlas and Titan missiles late in 1963 and the 150 Minuteman complex around Malmstrom AFB, Mont., by mid-1962.

This progress is in spite of many design changes that at one base already has increased costs sixty per cent and a continuation of jurisdictional labor strikes at several construction points.

One of the "incentives" in the Minuteman's construction is a $2,000 penalty for each day that a site runs over the contract-completion date.

• **Speedy Sub.**—ETHAN ALLEN, the first nuclear Polaris-launching submarine of a new class was launched in a record time of fourteen months from keel laying at General Dynamics Corporation's Electric Boat Division, Groton, Conn. The heaviest submarine ever launched in this country, she registers at 6,900 tons—almost 3 times the tonnage of World War II subs. She will be able to fire the 1,500-mile A-2 Polaris missile now under development.

• **Orbiting Weatherman.**—The Tiros II experimental meteorological satellite, in orbit since November 23rd, has been operating with such success that the Weather Bureau now advocates acceleration of the Nimbus project. Nimbus denotes the advanced type of weather-observation satellites planned for the mid-1960's. Now it is proposed that one ad-

vanced satellite be launched in 1962 followed by pairs as required.

Photographs from the Tiros II small-angle camera covering thirty square miles have been excellent and are being distributed to weather stations to assist in their forecasting. Although the wide-angle camera that covers 800 square miles has not been producing good pictures, all other features of Tiros II are working well.

• **Military Manpower.**—Increased military readiness ordered by President Eisenhower in August has encouraged the Army and Navy to keep their personnel totals well above the limits they are authorized to have by June 30th. The Air Force is about 10,000 under its allotted strength of 825,000 but plans to recruit to full allowance. The Army, now some 11,000 over authorized strength, probably will have to reduce to 870,000 unless more outbreaks occur overseas.

The Navy is 9,000 over its authorized 619,000 but hopes to be allowed to hold at 625,000. Navy admirals point out that, although the active fleet has been cut to a perilous low, all the newer ships require more men. For example, Essex-class carriers carried 2,040 men; the Forrestal needs a crew of 2,650—30 per cent more. Old destroyers required 250 men; the new Farragut type, 350. There are two crews to be furnished for Polaris-firing submarines, all highest-caliber men.

• **The Crowded Air Waves.**—The Army, like all services, is faced with an overcrowded radio spectrum as the number of its electronic communication devices used in the field has increased threefold since World War II. In addition, its reconnaissance drones, devices for proximity-fuzed shells, and radar to detect enemy movements all demand a share of the radio frequencies.

To attack this problem an electromagnetic environmental test facility is being established by the Signal Corps in Arizona. Here electronic engineers will determine adequate power and range limits for new equipment and test new transmitting techniques. It is believed that a great deal of the present equipment will be found to be unnecessarily overpowered.

• **Undersea Warfare Developments.**—Antisubmarine warfare is vastly complicated by detection and identification problems, but recent developments show promise. A World War II destroyer skipper felt lucky if he made a sonar contact at 2,000 yards, but last year the Navy was hinting that its new sonars might range out to over 10 miles under ideal conditions.

Now Rear Adm. Lloyd M. Mustin, executive to the Chief of Naval Operations for ASW, has alluded to sonar equipment under test that may detect submerged submarines at ranges of thirty miles or more.

In this field a challenge to industry was issued by Rear Adm. Charles E. Weakley, Commander, Destroyer Force, Atlantic Fleet, at an A.O.A. meeting in Hartford, Conn. Without being specific, he said that the range of underwater detection exceeded that of underwater weapons and it was high time that Ordnance-minded men and industries "do something about this"!!

Another phase of undersea warfare is the need for a submarine early-warning line off our coasts similar to the radar DEW line in Canada to detect bombers. This is under study by the Navy with no break-through in sight as yet.

To expand our knowledge and help to solve these problems the Argus Island, a "Texas-tower" type of installation, has been built in 250 feet of water 30 miles off Bermuda to measure acoustical properties of the ocean and test underwater detection equipment. The Navy also hopes to contract this year for surveys and studies for an Atlantic Underwater Test and Evaluation Center and is dickering with Great Britain for an area in the Bahamas.

An underwater missile-testing range similar to the airborne missile-testing range centered at Cape Canaveral, Fla., is sorely needed so that tests can be completely instrumented instead of being held in random areas that lack fixed recording and observing devices.

• **Space Age Gripes from the Old Army.**—The Army grows increasingly indignant over limitations of size, weight, and range of its aircraft and missiles. The other services, they point out, are not curtailed by paper restrictions but only by environment, so why handicap the Army?

Old Army men also are aggravated when they see the proponents of aerospace war planning to conduct operations from railroad trains and underground bunkers, once primarily the milieu of the Army. An additional restriction is a tight ceiling on the number of pilots allowed Army aviation.

• **Secrecy and Missile Costs.**—The Air Force Minuteman ICBM, exceeding all expectations, is scheduled to be combat-ready at Malmstrom Air Force Base in mid-1962—a year ahead of original estimates. Over $800 million is budgeted for this program in fiscal 1962. The underground launching has presented more problems than the missile itself, and the most worrisome obstacle to meeting dates appears now to be completion of sites for the first squadron at Malmstrom.

Although Minuteman, compared with Atlas or Titan, will carry a less potent warhead, it has equal range, costs only one-tenth as much, and requires about one seventh the number of personnel. No comparisons as to accuracy have been made, but it can be assumed that Minuteman will have adequate accuracy.

The great unknown seems to be the location of Communist missile sites, whereas ours are all so well identified in commercial publications that with a set of 25-cent large-scale maps from the Department of Interior one could pinpoint them all within the blast area of a megaton warhead or less.

Thus this country must have literally hundreds of missile-launching sites—expensively hardened in hopes that at least 10 to 15 per cent will escape damage if we should be attacked so that we will have some retaliatory potential. If more secrecy were practicable, millions could be saved in site construction.

There will be some gain in concealment when part of the Minuteman force is mounted on railway cars, estimated to be operational in 1963-1964.

Silence, Too, Is a Weapon

An Editorial

IN this place in our last issue an analysis was presented of the use of propaganda by Communist spokesmen in their deceitful drive for disarmament.* In that editorial we stated the obvious and time-proved truism that words are powerful weapons. At times, words are more powerful than nuclear warheads. There was considerable commendation of our position by many readers. The editors are grateful.

Now, it seems to us, in the same general discussion there is almost as much to be said about *silence as a weapon*. In this area, too, the Communists are expert. They rant and rave about their enemies' military posture, but they are mute about their own—except to threaten and claim their ability to reduce the world to a shambles whenever the Party so decrees. To the illiterate and immature, the Communist technique is not obvious. Hence the danger lies in the vast numbers of shallow-thinking Americans who are taken in.

There is little that is new in this Communist technique. What is new is the use of the word and the use of silence as weapons. By their use of both, psychological warfare is waged with consummate effect in this, the twentieth century. If our people had the slightest enduring interest in military history they could appraise easily the cunning and chicanery with which the war of words is being fought by the Communists.

THERE are times when silence is as effective as the spoken and written word. One such area is the frequent disregard by the press and news media of security regulations of the defense establishment. In particular, we cite the abandon with which certain elements of the press disclose military information which is rightly treated by the armed forces as of prime military secrecy. This is a flagrant violation of military security and is deserving of unqualified condemnation.

We thoroughly subscribe to the position recently stated by the Assistant Secretary of State for Public Affairs, Andrew H. Berding, at a meeting of the Associated Press managing editors at Williamsburg, Va. Secretary Berding said:

"Another responsibility I should like to comment on can be called 'responsibility to the Government.' One aspect of such responsibility has to do with the publication by newspapers of the texts of documents which are highly classified.

"These documents, as per regulations, are marked on each page at the top and at the bottom 'Top Secret,' 'Secret,' or 'Confidential,' depending on the degree of classification. There can be no doubt in the newspaper editors' minds that the documents are classified.

"When these documents are published, the newspapers themselves generally state that they are secret or confidential papers, and yet they proceed to print them in full. They do so without any intimation of excuse or explanation. They do so without any inquiry of any Government agency as to whether the publication would injure our relations with other countries mentioned in the documents or impair the standing of our Nation.

"Since documents so classified have only official circulation, it is obvious that a Government official, in violation of the rules of official conduct and of ethics, has given them to unauthorized persons. The newspapers condone this violation by making the most of it.

"In the scores of columns of space devoted to the classified documents that have been published, I have yet to see any slightest question of whether it was right or wrong to publish secret official documents.

"You might say: 'Well, the Government should not have marked the documents secret or confidential.' Even if that be admitted, it is legitimate to ask: 'Does the newspaper have the sovereign right to determine by itself that the Government is wrong when it wants to protect national security by classifying a document?'

"I am more than willing to grant that documents are often unnecessarily classified, or too highly classified, although considerable improvement has been registered in the right direction in recent years. But, once the document is in fact classified, a newspaper takes upon itself a special responsibility when it publishes it.

"What makes me wonder is less the fact of this publication than the disturbing fact that no one seems to think it in any way unusual."

Mr. Berding brings out cogently the importance of silence as a weapon. In a world where military strength is the only bulwark to protect the liberty of the individual against Communist domination, the wanton disclosure of classified military information is an effective aid to the enemy.

The device of marking a military document as "Secret" to cover up mistakes is, of course, reprehensible. To use the same device as a shield for inefficiency, waste, or sheer laziness is an attempt at deception unworthy of the military profession. Such uses have been known to exist.

But an editor worthy of his salt, much less his American citizenship, should be able to distinguish the sham security label from the bona fide. In conscience, he has a choice about disclosing the former but, equally important, he has the duty not to reveal the latter.

ALL this should be, and, in the great majority of cases is, self-evident. Truth to tell, the violations of security are few and far between. The guarding of military information by the press is, for the most part, an obligation which most editors and reporters meet with admirable diligence.

Nonetheless, the violation of the secrecy classification when it occurs is handing to the enemy a weapon—frequently a powerful weapon—of which continued silence would have deprived him.

* On October 31, 1960, the third year of talks began at Geneva, Switzerland, to achieve a treaty reducing the dangers of nuclear weapons. On that day the 261st meeting was held by representatives of the United States, Great Britain, and the Soviet Union. Results: Nil.

Production for Defense

A report on the 42nd Annual Industrial Preparedness Meeting

THE Forty-Second Annual Industrial Preparedness Meeting of the American Ordnance Association in New York City on December 7th was a glowing success in that all affairs brought out capacity crowds and, although there were several innovations, every event functioned smoothly.

The seminars on production, usually considered a dull subject except to a particular producer, were immensely successful, and the attendance filled the Empire Room of the Waldorf-Astoria Hotel to capacity.

The program was introduced by the Association's president, Louis Polk, a master of production in his own right as president of Sheffield Corporation—an organization that builds gages and machine tools, the backbone of production.

Deputy Assistant Secretary of Defense for Supply and Logistics Russell A. Crist set the theme for this Industry-Ordnance Team presentation in which each military Ordnance chief introduced his principal officers in charge of production and a 3-man industrial team.

For the Army, Lieut. Gen. J. H. Hinrichs, Chief of Ordnance, presented Maj. Gen. Gunnar C. Carlson, Chief, Industrial Division, Ordnance Corps; Paul L. Davies, chairman, Food Machinery and Chemical Corporation, San Jose, Calif.; W. Miller Hurley, vice-president, Winchester-Western Division, Olin Mathieson Chemical Corporation, New Haven, Conn.; and Walter Herr, Western Electric Company, New York, N. Y.

The Navy's production expert and industrial team introduced by Rear Adm. P. D. Stroop, Chief, Bureau of Naval Weapons, consisted of Rear Adm. J. E. Dodson, Assistant Chief, Bureau of Naval Weapons—Fleet Readiness; Henry F. Argento, vice-president and general manager, Philco Corporation, Philadelphia, Pa.; John B. Hawley, Jr., chairman of the board and president, Northern Ordnance, Inc., Minneapolis, Minn.; and Dr. Ernest Roberts, assistant plant manager, Solid Rocket Plant, Aerojet-General Corporation, Sacramento, Calif.

Lieut. Gen. Mark E. Bradley, Jr., Deputy Chief of Staff, Matériel, United States Air Force, Washington, D. C., presented Maj. Gen. W. Austin Davis, Commander, Aeronautical Systems Center, Air Matériel Command, Wright-Patterson Air Force Base, Ohio; J. R. Dempsey, vice-president and manager, Convair Astronautics, General Dynamics Corporation, San Diego, Calif.; Dr. Norman Grossman, chief, equipment engineering, Republic Aviation Corporation, Farmingdale, N. Y.; and Harold R. Raynor, assistant general manager, Missile Division, North American Aviation, Inc., Los Angeles, Calif.

As each industrial speaker was faced with a restricted time limit, he concentrated on one or two of the most interesting or unusual production problems that had been mastered by his company. The fast tempo of the presentations and the great variety of subjects discussed made each session a lively one.

At the annual Armament Preparedness Luncheon, Lieut. Gen. Blackshear M. Bryan, president of the New York Post, presided over a packed house in the Starlight Roof of the Waldorf-Astoria.

The guest speaker, Robert W. Henderson, vice-president, weapons programs, Sandia Corporation, Albuquerque, N. Mex., stressed that extremely high reliability must be built into atomic weapons as penetration to the target by bombers may be difficult, "therefore the warhead that does get there had darn well better explode." He described the methods used by Sandia Corporation to ensure the necessary reliability.

THE dinner meeting in the Grand Ballroom was the equal in magnificence of any previous affair, with an impressive representation of industry and all the services. General Bryan welcomed the assembly and introduced Mr. Polk as toastmaster who reviewed the objectives and achievements of the Association.

Then came the surprise of the evening, the presentation to the Association of the Defense Department's Meritorious Award by Assistant Secretary of Defense Murray Snyder. The citation states in part:

"The American Ordnance Association has for more than forty years led the civilian forces of industrial mobilization of the Nation and has become recognized as a vital element in the armament preparedness of the United States. Throughout the Association's long service to the national defense its activities have been ever characterized by intense loyalty, patriotic cooperation, and practical results." The citation is quoted in full in THE COMMON DEFENSE for January 1961.

The presentation of the Association's Crozier Gold Medal to the guest of honor, Gen. Thomas D. White, Chief of Staff, United States Air Force, was conducted by Lieut. Gen. Levin H. Campbell, Jr., A.O.A. director, who read the citation, and by Harvey C. Knowles, Association vice-president, who pinned the Medal on General White.

The general electrified the audience by announcing that Discoverer XVIII, the Air Force experimental reconnaissance satellite, had just been put into orbit.

IN his address, General White emphasized the vital importance of striving for effective manned aerospace operations as an important feature of our national security.

"The interest and support of the American Ordnance Association in scientific and industrial military preparedness," said General White, "is a most important contribution to our country's total defense effort. This is especially true in today's technological race when the armed forces must depend—more than ever—upon the skills, talent, ingenuity, and cooperation of U. S. science, industry, and labor.

"There can be no question that close partnership between all participants is a continuing requirement if this country is to possess the military strength it needs to survive as a free nation. . . .

"Nuclear weapons, then jet aircraft, and now ballistic missiles have necessitated a reassessment of our strategies and concepts to ensure our possession of the means to withstand a surprise attack and preferably to prevent it.

"In these evaluations, one thing has become abundantly clear—despite new variables, the one constant factor is still the requirement for dominant military force which can repel and decisively counter any blow against us—regardless of circumstances.

"This means winning military strength—strength which concomitantly provides the greatest hope that aggression against this nation—or against our friends and allies—will never take place."

In addition to the seminars and the luncheon and dinner meetings on December 7th, the Association's Board of Directors, the national Council, and the Post presidents met on December 6th at the University Club in New York, and the technical Division's Executive Technical Board held a session on December 8th. Their proceedings will be reported in later issues of ORDNANCE.

ASSOCIATION AFFAIRS

Northwest Post Visits Missile Site, Participates In Business Exhibit

The Northwest Post, besides undertaking an activity of its own, joined the sponsors of the Business Opportunities Exhibit in their opening dinner and exhibit at the St. Paul Auditorium, St. Paul, Minn., in December.

The Post also had a booth in the exposition for the entire period for the purpose of explaining the aims of the A.O.A., distributing literature, and soliciting memberships from companies and individuals.

J. J. Dalglish, president of the Northwest Post, left, and C. A. Knapp, Post vice-president, center, are greeted by Captain Monroe, battery commander, right, on the arrival of the Post contingent to inspect the Nike antiaircraft missile site at Farmington, Minn., including assembly, fueling, and missile-launching areas.

The special Post activity consisted of a tour of the Nike missile site at Farmington, Minn., on October 5th when forty members boarded a chartered bus in St. Paul to visit the Nike site. There was a fine demonstration of the workings of the Nike weapons system, including the assembly and fueling sections and the launching area. A demonstration by the night-sentry dogs and their trainers also proved interesting.

In the administration building a film was shown on the development, manufacture, testing, and operating of the Nike system, including some excellent pictures of actual firings at drone planes from the range at White Sands, N. Mex.

Afterward Captain Monroe, the battery commander, held a press-conference type of discussion, with the members acting as probing reporters. Some indication of the interest of the members was the fact that over forty questions were asked and the answers discussed.

Powder Metallurgy Steering Committee Meets At Dayton To Discuss Policies

The new Steering Committee of the Powder Metallurgy Section met at Dayton, Ohio, under the chairmanship of N. L. Gebhart, general manager, Delco Moraine Division, GMC, Dayton, Ohio.

The chairman announced his policy of administering the Section largely through the Steering Committee. Recommendations, therefore, to strength Section activities were requested. Initially, the discussion concerned increasing the size of the Steering Committee to obtain broader industrial representation. This was approved, and additional members will be invited to serve on the committee.

The committee acquiesced to the request of Chalmers Dale, Charles Hardy, Inc., New York, that he be relieved of the secretaryship which he had held for many years. It was unanimously voted to ask Mr. Dale to serve as deputy chairman.

The Section organizational structure was discussed and four subsections were established. These subsections and their chairmen are: Raw Materials, B. T. DuPont, Plastic Metals Division, Crane Company, Johnstown, Pa.; Fabricated Products, W. P. Balthrop, president, Amplex Division, Chrysler Corporation; Equipment, W. R. Toeplitz, president, Bound Brook Oil-Less Bearing Company, Bound Brook, N. J.; and Research and Development, W. A. Reich, manager, future products division, Carboloy Division, General Electric Company, Detroit, Mich.

The December meeting of the Section was set for December 14th at the Naval Ordnance Laboratory, Silver Spring, Md.

Discussions next centered on the format of future meetings. It was generally agreed that the format must be flexible to meet the needs of any specific meeting and that it might consist of formal papers, presentations of problems, or panel-type discussions.

It was agreed that one general meeting a year was necessary. Subsections or the Steering Committee would meet as required to accomplish their missions.

It was noted that the membership list is under constant scrutiny and inactive members are being dropped. Additional members will be recruited as needed to meet Section requirements.

A.O.A. Liaison Committees Meet In Washington, D. C. To Review All Operations

In November a series of meetings was held with Liaison Committees of the Association. The opening meeting on November 4th, was with Marine Corps

personnel who have been active in the A.O.A. technical operations.

U.S.M.C. members present for that meeting included: Col. G. E. Moore, Ordnance Branch, G-4, Division Headquarters, U.S.M.C., who is a consultant of the Artillery Division; Lieut. Col. F. R. Stewart, Jr., of the same office, who is a consultant for the Combat & Tactical Vehicle Division; and Maj. E. R. Coffeen, Marine Corps Liaison Officer, O.C.O., a consultant of the Special Committee on Recoilless Rifles and Ammunition Systems. Maj. John H. Miller of Colonel Moore's office also attended.

The Air Force Liaison Committee met on November 10th under its chairman Brig. Gen. R. D. Curtin, Director, Office of Missile and Satellite Systems, Office of the Secretary of the Air Force. Other attendees included Col. J. C. Maxwell, Office, Assistant Deputy Chief of Staff, Headquarters, ARDC; Col. E. T. Reichert, Community Relations Division, Office of Information, Headquarters, U.S.A.F.; and Col. E. V. Conkling, Directorate of Research and Development, Office, Deputy Chief of Staff/Development, Headquarters, U.S.A.F.

Jesse Hadley, Bendix Corporation, Washington, D.C., chairman of the Missiles and Astronautics Division, attended with Maj. Gen. E. P. Mechling, U.S.A.F. (Ret.), and Col. H. C. Thayer, U.S.A. (Ret.), both from A.O.A. national headquarters.

The third meeting in November was with the Navy Liaison Committee under the chairmanship of Rear Adm. C. T. Booth, Assistant Chief of the Bureau of Naval Weapons for Program Management. Other BuWeps personnel present included: Capt. F. A. McKee, Director for Air Defense Warfare Programs; Capt. J. R. Middleton, Missile Branch Head, Special Projects Office; and F. M. Gloeckler, Assistant Research and Engineering Officer, who is secretary of the Committee.

Dr. G. R. Tatum, Director, Vitro Laboratories, Silver Spring, Md., chairman of the Underwater Ordnance Division, also attended with General Mechling and Colonel Thayer.

Discussion at all meetings reviewed the progress in technical operations during the past year, reorganizations and changes in personnel that have occurred, and projected plans and operations for the coming year.

Particular emphasis was placed upon the improvement of liaison with the services during the months ahead.

A.O.A. Electronics Division Holds Meeting At Pacific Missile Range

The Electronics Division held its fall meeting on the West Coast in late September. More than fifty members and consultants met at the call of Maj. Gen. F. L. Ankenbrandt, U.S.A.F. (Ret.), Radio Corporation of America, Defense Electronic Products, Camden, N. J., the Division chairman.

The Pacific Missile Range (PMR) was host for the meeting. Rear Adm. Jack R. Monroe, Commanding Officer, PMR, greeted the attendees at Point Mugu and was the principal speaker at the Division dinner.

The meeting opened with descriptions of the Pacific Missile Range, the Naval Missile Center, and the Navy missile program. Following a presentation of the Air Force programs at PMR, there was a buffet luncheon. After lunch, the Army programs were presented and then technical presentations were made by government and industry representatives.

On the second day of the meeting, the Division toured the facilities of Point Mugu. After lunch the meeting moved to the Santa Barbara Biltmore Hotel where Division and Section meetings were held.

The members visited Point Arguello on the third day. The briefing on the Point's activities and facilities, followed by tours of the area, concluded the basic agenda of the meeting.

Shown above are members and consultants of the A.O.A. Electronics Division attending the fall meeting of the Division at the Pacific Missile Range.

Hon. Perkins McGuire Is Guest Of Honor At November Meeting Of Washington Post

Hon. E. Perkins McGuire, the Assistant Secretary of Defense for Supply and Logistics, guest of honor at the monthly luncheon meeting of the Washington Post, spoke to over 330 members on November 17th.

Post President M. C. Richmond praised the accomplishments achieved by Secretary McGuire and urged industry to give closer support to the Defense Department. He then introduced the very distinguished head-table guests and called on Louis Polk, president of the A.O.A., to present Secretary McGuire. Mr. Polk spoke of the importance of economy in defense logistics and noted the effective steps the Secretary has undertaken to promote good management.

Secretary McGuire emphasized the nature of the Communist threat that forces us into our high budget. He said:

"Defense now takes one out of every two dollars in the Federal budget. The annual defense expenditures approximate the total personal income tax of the entire United States. Under these conditions, good management is to cold war what strategy and tactics are to a hot war."

Recounting some of the areas in which improved management practice has saved money he said:

"In 1957 our supply inventories had reached $54 billion. During the past 3 years we have shown a decrease in each year, and our inventories are now at the level of $44 billion, a reduction of $10 billion dollars.

"In 1958, by screening the excess inventories of one service against requirements of another service, the services drew from each other's excess inventory $587 million of supplies. This is a direct savings. If this had not happened they would have gone to the open market and purchased this amount of supplies.

"Just to prove that it wasn't an accident and that we are continuing to improve, in 1959 it was almost $1.25 billion and in fiscal 1960 it was $2 billion.

"By reducing inventories we, of course, need less inventory space. During the past year we have inactivated over 4 million square feet of space. Exploring space usually costs big money. In this case, we have saved money by exploring space."

Distinguished guests at the speakers'

table were: William E. Haines, vice-president, Washington Post, A.O.A.; Maj. Gen. Gunnar C. Carlson, Chief, Industrial Division, Office, Chief of Army Ordnance; Rear Adm. Henry S. Person, Director of Logistics, Joint Staff, Joint Chiefs of Staff; Thomas C. Werbe, Jr., Deputy Assistant Secretary of Defense (Supply and Logistics).

Also, Maj. Gen. W. O. Senter, Assistant Deputy Chief of Staff, Matériel, Air Force Headquarters; Hon. George H. Roderick, Assistant Secretary of the Army (Financial Management); Lieut. Gen. John H. Hinrichs, Chief of Army Ordnance; Hon. Cecil P. Milne, Assistant Secretary of the Navy (Material); Lieut. Gen. R. W. Colglazier, Jr., Deputy Chief of Staff for Logistics, Department of the Army.

Also, Rear Adm. Floyd B. Schultz, Assistant Chief of the Bureau of Ships for Technical Logistics; Aaron J. Racusin, Deputy Assistant Secretary of the Air Force for Procurement and Production; Maj. Gen. Marshall Stubbs, Chief Chemical Officer, Department of the Army; Philip LeBoutillier, Jr., Deputy Assistant Secretary of Defense (Supply and Logistics).

Also, Rear Adm. Paul D. Stroop, Chief, Bureau of Naval Weapons; Hon. Courtney Johnson, Assistant Secretary of the Army (Logistics); and Vice Adm. John Sylvester, Deputy Chief, Naval Operations (Logistics).

Hon. Cecil P. Milne Opens Fall Series Of Washington Post Luncheon Meetings

The Washington Post opened its monthly luncheon meeting series with an outstanding affair in honor of the Assistant Secretary of the Navy for Material, Cecil P. Milne. Over 250 members and guests assembled in the grand ballroom of the Willard Hotel to greet the Secretary on Thursday, October 20th.

The presiding officer, Millard C. Richmond, conducted a special drawing for prizes that remained after the previous month's golf outing. Fifteen lucky members won useful items including an electric roaster and golf and other sporting equipment.

Mr. Richmond also presented the miniature cups won at the golf tournament by William Brownrigg for low gross and by William Walker for low net. These were replicas of the large cups presented by U. S. Steel Corporation and International Harvester Company on which winners' names are inscribed.

Mr. Richmond also presented a certificate of appreciation on behalf of the national directors of the Association to Stewart L. Magee, past president of the Post, in recognition of his outstanding leadership in the previous year of activity in the Nation's Capital.

In connection with his introduction of Secretary Milne, the presiding officer presented him with a membership in the Ordnance Association.

Secretary Milne gave a clear and forthright presentation of the "Challenges to Our Business Management." He said that the goal of the military and their partners in industry is to reduce costs without sacrificing essential quality, quantity, or performance.

The Secretary pointed to the following management areas where industries could make important contributions: closer pricing in making subcontracts, a tightening of overhead and administrative expenditures, a reduction in the cost of new facilities, and more discrimination in the purchase of drawings.

In the latter area it was pointed out that industry could contribute by bringing excessive drawing requirements to the attention of the military.

Millard C. Richmond, Washington Post president, is shown at left above presenting an A.O.A. membership certificate to Assistant Navy Secretary Cecil P. Milne.

After praising in general some of the outstanding industry-defense achievements, such as the Polaris program, Mr. Milne pointed out how Defense was improving its business management.

Among numerous items he noted the success of the Navy's program evaluation and review technique to systematize progress in a weapons system, value engineering, utilization of more industry specifications in place of restrictive military specifications, scientific techniques of inventory management, and a vast simplification of material requisitions from the Fleet.

In closing, Secretary Milne said: "Our challenge is clear and implacable. I urge you to accept it first by handling defense dollars in the most economical way possible; secondly, by getting across to the public—our shareholders—the story of the good aspects of our management."

Others seated at the head table were: Hon. Courtney Johnson, Assistant Secretary of the Army (Logistics); Hon. Philip B. Taylor, Assistant Secretary of the Air Force (Matériel); Vice Adm. G. F. Beardsley, Chief, Office of Naval Material; Rear Adm. P. W. Snyder, Vice Chief, Office of Naval Material; Rear Adm. William A. Schoech, Deputy Chief, Bureau of Naval Weapons; Lieut. Gen. John H. Hinrichs, Chief of Army Ordnance.

Also, Rear Adm. C. T. Booth, Assistant Chief for Program Management, BuWeps; Brig. Gen. S. R. Hanmer, Deputy Chief of Engineers for Military Operations; Brig. Gen. F. J. McMorrow, Director of Procurement, Office of the Army Chief of Staff; and J. Geddes of N.S.I.A.

Brig. Gen. Oren Hurlbut Addresses Members Of The Quad Cities-Iowa Post

The fall dinner meeting of the Quad Cities-Iowa Post was held in the Rock Island Arsenal post restaurant on November 18th.

A. Linton Lundy, Post president, gave especial recognition to members from areas outside of the Quad Cities; these included Lohrville, Burlington, Dubuque, and Waterloo, Iowa.

Col. Stanley Smiley, acting for the commanding officer, welcomed the guests to Rock Island Arsenal and mentioned the good relations existing between the arsenal and A.O.A. members extending through the past fifteen years.

Col. William H. Sparrow from the Chicago Ordnance District was then introduced. He indicated that he had just recently been assigned to the Chicago Ordnance District office but that the close relationship between the arsenal, the A.O.A. members, and the Ordnance District was a well-known fact and that they appreciated these contacts in the district office, as well as the opportunities to attend our meetings and to meet with industrial and military leaders within the Post area.

The principal speaker, Brig. Gen. Oren E. Hurlbut, Commander, Ordnance

Weapons Center, spoke on "Modern Arms for a Modern Army."

His talk dealt with the tools used by the foot soldier who remains the ultimate weapons systems in a modern army. He described, with actual models and visual aids, the operating principles of rifles, machine guns, and grenade launchers. He then outlined operational capabilities of the Davy Crockett system which places atomic firepower in the hands of the foot soldier.

Following this portion of the talk, Col. Richard Rastetter, Project Officer of the Davy Crockett system, supplemented General Hurlbut's remarks with a description of the manufacturing problems connected with both the light and heavy Davy Crockett weapons. This was further illustrated by an actual field-type assembly with the light weapon accomplished by men who are in training on this work at Rock Island Arsenal.

Comdr. George F. Moran Tells "Polaris Story" To Members Of The Birmingham Post

"The Polaris Story" attracted over 170 members to the Birmingham Post fall luncheon meeting at the Tutwiler Hotel.

Comdr. George F. Moran, from the

Comdr. G. F. Moran, Navy Special Projects Office, is shown at left, above, chatting with L. F. Jeffers, Birmingham Post president, during Post meeting (Army photo).

Navy's Special Projects Office and one of the Navy's most accomplished "presenters," was the guest of honor and with his film and comments covered the development, production, and operation of the Polaris weapon system. He called this missile the most powerful force for peace in the world today, stating that in case of attack and possible destruction of land bases the Polaris submarines will be stationed around the world underwater to guarantee counterattack on an aggressor.

The submarines GEORGE WASHINGTON and PATRICK HENRY, now ready for action, are the first results of the present program of the Navy Department to build forty-five such submersibles.

"The main goal of the Polaris is to serve as a threat of retaliation in case an aggressor tries to attack the free world," Commander Moran said.

In terms of firepower, one submarine carrying sixteen Polaris missiles can unleash more destructive might than the weapons used by both sides during World War II, he stated. Our hope, he concluded, is that the existence of the Polaris missile will deter all possible aggressors and therefore prevent war.

During the luncheon, Post President Lewis F. Jeffers presented A. B. Schwartzkopf, past president, the Association's Citation of Appreciation in recognition of his effective leadership of the Post.

Nonferrous Metallurgy Group Meets At Frankford Arsenal To Hear Technical Papers

The second meeting of the Nonferrous Metallurgy Section, A.O.A. Materials Division, was held at Frankford Arsenal, Philadelphia, Pa., on November 16th. The chairman, Dr. W. A. Dean, Aluminum Company of America, Pittsburgh, Pa., presided.

Col. A. R. Cyr, Commanding Officer, Frankford Arsenal, was host and attended the meeting. After he greeted the Section, six technical papers on nonferrous problems were presented by Ordnance representatives. Some papers permitted immediate response from the Steering Committee but others necessitated the appointment of ad hoc committees to prepare written reports.

The problems discussed involved uses of aluminum, magnesium, beryllium, and titanium.

Following luncheon, Section members toured the nonferrous metallurgy laboratories at the arsenal and observed the effective work that Frankford has been doing in this area. It is planned to hold the next meeting in the spring at the Wright-Patterson Air Force Base, Dayton, Ohio.

General Carpenter Addresses Meeting Of The Florida Post At Eglin AFB

A fall dinner meeting of the Florida Post was held at the Eglin Air Force Base Officers' Club to honor Brig. Gen. J. W. Carpenter, III, Commander, Air Force Flight Test Center, Edwards Air Force Base, Calif. Col. H. J. Crumly, Post president, presided and after introducing the guests called on Carl Kyselka for the secretary's report.

Lieut. Col. William M. Land, Jr., chairman of the nominating committee, announced the candidates recommended to fill the eight vacancies on the board of directors.

Maj. Maurice J. Street spoke briefly on patent application procedures and expressed appreciation for the cooperation he was receiving in the patent field from APGC personnel. Col. Herbert M. West, Jr., mentioned the letters patent issued recently to Maj. E. C. Roser, Martin P. Brown, and A. G. Bilek, pointing out that such successful applications added greatly to Center prestige.

General Carpenter gave a comprehensive briefing on the facilities and capabilities of the AFFTC, together with several most interesting films of actual test operations. His major topics included the discussion of the organization and

Shown above during Florida Post meeting are, left to right: Col. Harold J. Crumly, Commander, 3208th Test Group, Air Proving Ground Center; Brig. Gen. J. G. Shinkle, Commander, White Sands Missile Range; Col. H. M. West, Jr., Chief of Staff, APGC; and Brig. Gen. J. W. Carpenter, III, Commander, Air Force Flight Test Center, Edwards Air Force Base, Calif., the guest of honor and principal speaker at the meeting.

mission of his command, future B-70 evaluation program, barrier and spin testing, X-15 escape system, VTOL aircraft, X-1A, X-2, and X-15 flight testing.

He also discussed the retardation (parachute) recovery program, future work on B-70 testing at Mach 3 and 80,000 feet altitude, bridging the gap between space ships (such as Dyna-Soar) and present aircraft, and the development of high-performance rocket propellants.

The Florida Post reports that it started activity in September with a fish fry on Cinco Bayou. Many guests were invited in order to introduce them to the personnel of the Post.

Volunteer Post Pays Annual Visit To Missile Command At Redstone Arsenal, Ala.

The Volunteer Post made its annual fall field trip to the U. S. Army Ordnance Missile Command at Redstone Arsenal, Ala., on Wednesday, November 9th with forty-five members and guests in the party.

They were welcomed by Maj. Gen. August Schomburg, Commanding General, Army Ordnance Missile Command, and given a briefing on the organization of AOMC and the day's schedule. After viewing the films "Army Family of Missiles" and "The Nike Zeus," they inspected the Fabrication Laboratory where experimental missiles and launchers are put together.

Following luncheon where General Schomburg presented the Association's Certificate of Appreciation to F. Donald Hart, past president of the Post, the members were shown the testing of missile components, visited the Guided Missile School, the test range, and the museum. Before returning, all hands assembled at the Officers' Club for refreshments and dinner.

New York Post Holds Luncheon Meeting, Sponsors Seminar Series In Town Hall

The New York Post held a fall luncheon meeting in the Cloud Room at Roosevelt Raceway, Westbury, L. I. The luncheon, attended by over 150 members and guests, was presided over by Lieut. Gen. Blackshear M. Bryan, U.S.A. (Ret.), president of the Post.

The principal speaker at the meeting, Maj. Gen. Alfred F. Kalberer, Deputy Commanding General of the Air Defense Command, discussed the defense readiness and strength of the Nation.

Honored guests included Lieut. Gen. William E. Hall, Commanding General of the Continental Air Command, and Lou Davis, director of the Army Ordnance Standardization Exhibit.

This meeting highlighted the exposition at the Roosevelt Raceway that was sponsored by the New York Post in cooperation with the New York Ordnance District.

The huge standardization exhibit, occupying a space 40 by 80 feet, was developed by the Ordnance Tank-Automotive Command, Detroit, Mich. The display was a panorama of all the latest Army equipment, ranging from missiles to bolts and rivets. It was designed to show the public and the military how standardization increases the operational efficiency of the armed forces and at the same time saves the tax dollars of the defense budget.

The first of an ambitious series of seminars planned by the New York Post to highlight the equipment problems of our armed forces also was an outstanding success. Almost 600 members and guests turned out at the Town Hall on October 19th to attend a briefing session on the Army's equipment requirements conducted by some of its more distinguished officials.

Attending New York Post meeting are, left to right: Lloyd W. Stearns, Post director; William L. O'Donovan, Post vice-president; Maj. Gen. Alfred F. Kalberer, Deputy Commanding General, Air Defense Command, the principal speaker; Lieut. Gen. Blackshear M. Bryan, New York Post president; and Lieut. Gen. William E. Hall, Commanding General, Air Defense Command. More than 150 members and guests attended.

Hon. George H. Roderick, Assistant Secretary of the Army for Financial Management, was the first speaker. He was introduced by Lieut. Gen. Blackshear M. Bryan, the presiding officer and Post president.

Secretary Roderick, speaking on "The Task of the Army-Industry Team in Modernizing the Army," noted that industry today is closely involved in every phase of the military process from research to observing the operational equipment in service. He emphasized that this partnership has two special tasks, one to reduce lead time for new equipment, the other to carry on full research programs.

The Secretary said, "It is our national policy not to attempt to match the Communist manpower in numbers but to excel by superior weapons and equipment," and then spoke about the Army's plans and progress in its modernization program.

Maj. Gen. William W. Dick, Jr., Deputy Chief of Army Research and Development, explored the areas in which the Army and industry are striving to improve mobility. He described the basic research taking place on the interaction of terrain and moving land vehicles and described many of the vehicles in use or under development.

The general praised industry for its assistance in advancing air mobility and showed slides of new and novel experimental craft, such as flying disks, helicopters, and planes with rotatable ducts for vertical take-off. He also noted the progress being made in fuel cells for power and weight reduction achieved by the use of special alloys.

Col. James H. Hamill, Director, Ballistics Research Laboratories, Aberdeen Proving Ground, Md., spoke on "Research and Engineering for the New Weapons." He described the many areas of basic research in which his laboratories were involved with the help of other scientific organizations and industry.

Colonel Hamill explained how his computers helped to speed up the solution of many problems and how scientific break-throughs had led to unexpected developments in weaponry.

Maj. Gen. William D. Hamlin, Commanding General, Fort Monmouth, N. J., elaborated on communication problems and equipment. He mentioned the electronic missile components, the missile-tracking stations, the research into effects of nuclear radiation on electronic devices, and the Tiros weather satellite as some of the more interesting respon-

Attending New York Post seminar in Town Hall are, left to right: Maj. Gen. W. D. Hamlin, Commanding General, Fort Monmouth, N. J.; Hon. George H. Roderick, Assistant Secretary of the Army for Financial Management; Maj. Gen. Raymond W. Curtis, Commanding General, II Army Corps; and Col. James H. Hamill, Director of the Ballistic Research Laboratories, Aberdeen Proving Ground, Md. (Army photo).

sibilities of the Signal Corps. The latest tactical communication sets were then displayed and described by Mr. Colagouri of the Army Signal Laboratory in an interesting presentation.

An exciting feature of the session was a preview of the film, "Arms for Tomorrow," that demonstrated how the arsenals provide support and know-how in munitions development to industry, although budgetwise 97 per cent of Army ordnance actually was produced by private industry.

Prior to the seminar, officials of the Post were hosts to their distinguished guests at a dinner at the University Club.

"A.O.A. Week" Declared In Cleveland As Ordnance Fraternity Holds Meetings

By proclamation of the Mayor, the period October 17th-21st was designated "American Ordnance Association Week" in Cleveland, Ohio, and turned out to be one of the most timely and profitable series of meetings for all concerned.

It included the annual meeting of the Association's Cleveland Post, the semiannual meeting of the Association's Missiles and Astronautics Division, and the semiannual gathering of the Chief of Ordnance of the Army with all major commanders of the Corps in continental United States.

A highlight in the weeklong observance was the presentation of the Association's Benedict Crowell Medal to Lieut. Gen. John H. Hinrichs, Chief of Army Ordnance. The honor was conferred to testify to the Association's admiration and appreciation of his outstanding leadership. The medal was presented by Albert J. Weatherhead, president of the Post, before a distinguished company at dinner in the Carter Hotel on the evening of October 19th.

To take first things first, the atmosphere of the occasion was heightened by the presence in Cleveland of the Army Ordnance commanders whose deliberations were, of course, confined to the members of that group, but many of these officers participated also in the Cleveland Post assembly as well as in the deliberations of the A.O.A. Missiles and Astronautics Division. The annual banquet meeting of the Post was a gala affair. Cleveland leaders in the realms of industry, science, banking, and the arts were present in goodly numbers to honor General Hinrichs and to hear his address. More than six hundred were in attendance led by Mr. Weatherhead who presided and who read the citation which accompanied the award of the Crowell Medal to General Hinrichs.

In his remarks the general summarized the demands which are being made upon the Ordnance Corps and industry to meet today's production requirements. He placed special stress on the balance necessary to be kept between the vast resources in manpower and weaponry and the complex of government and industry supporting the military establishment.

"It would be a tragic mistake," he said, "to place reliance upon any one weapon system or an inflexible strategy when the choice of the means, time, and place of attack is the option of a potential enemy." Readiness for limited as well as unlimited conflict is essential, he said.

General Hinrichs paid a particularly moving tribute to General Crowell and to the Ordnance Association which he helped found.

"I am particularly humble," he said, "when I think of the tremendous accomplishments and great contributions made by General Crowell. His participation in the national-defense program during both World Wars set an inspiring example. Because of his contact with the production effort of World War I he saw the need for closer relationships between the scientific, industrial, and military communities to achieve and maintain a strong defense. That inspired him to found the Ordnance Association.

"Its success over the years is due in no small measure to the solid foundation which he built during his years as its president. Cleveland may well be proud of his lasting contributions to the Nation's military and industrial strength both within government and within the industrial and scientific community. He was a doer and a giver, a man of vision, and of integrity, who could turn a wish into reality.

"I am happy to assure you that the reality he created, the partnership of the Army and American industry, is more effective today than ever before in time of peace."

Sharing the rostrum with General Hinrichs was Brig. Gen. C. W. Clark, Chief of Army Ordnance Research and Development. He presented an illustrated talk on "Ordnance for Tomorrow," describing many of the advances that are under way and the ultimate goals hoped to be attained. The visual aids used by General Clark were especially timely and revealed the remarkable accuracy of the Nike Zeus as an antimissile missile.

He also exhibited for the first time in public the Army's new 40-mm. grenade launcher—a single-shot, break-open weapon using a 40-mm. cartridge. It provides the infantry soldier with a firepower equal to that of the old 60-mm. mortar at ranges up to 400 meters.

The toastmaster at the dinner was Thomas F. Patton, president of the Republic Steel Corporation and a director of the Cleveland Post. The invocation was given by Capt. Elijah A. Cockman, Chaplain, Headquarters 67th Artillery Group, Air Defense.

The following two days were devoted to deliberations of the several sections of the Association's Missiles and Astronautics Division under the chairmanship of C. L. Eksergian, Heintz Division, Kelsey-Hayes Company, Philadelphia, Pa. The

theme of this semiannual meeting was "Our Future in Space—A Mutual Concern."

The opening speaker was Maj. Gen. J. A. Barclay, Deputy Commander, Army Ordnance Missile Command, Redstone Arsenal, Ala., who discussed the Army's missile role.

Rear Adm. T. F. Connolly, Assistant Chief for Pacific Missile Range and Astronautics, Bureau of Naval Weapons, Washington, D. C., spoke on "Space—The Navy's Viewpoint."

The subject, "Military Requirements for Space," was presented by Maj. Gen. Marvin C. Demler, Director, Systems Development, U. S. Air Force, Washington, D. C.

The closing discussion, "Analysis of Materials and Manufacturing Requirements for Aerospace Systems," was given by W. J. Eding, Materials Advisory Board, Division of Engineering and Industrial Research, National Academy of Sciences, Washington, D. C.

At luncheon, A.O.A. President Louis Polk, Sheffield Corporation, Dayton, Ohio, presided. The A.O.A. Bronze Medallion was awarded to Mr. Eksergian for his many years of hard work and effective leadership in organizing and building up the Missiles and Astronautics Division. The presentation was made by Harvey C. Knowles, Procter & Gamble Company, Cincinnati, Ohio, the senior vice-president of the Association, and by Col. Henry N. Marsh, Wilmington, Del., A.O.A. vice-president for technical Divisions.

The afternoon was allotted to separate meetings of the Sections. Each Section had presentations of papers of particular application to their scope of interest. A total of fifteen technical papers were presented, while the Systems Section held a panel discussion on the development problem for space systems. Some interesting and unique topics were explored.

At the evening banquet, the Scott Gold Medal was presented to Dr. H. Guyford Stever and is reported in this issue of ORDNANCE (see page 526).

On October 21st, the Division visited the Lewis Research Center of NASA where they were welcomed by Dr. E. R. Sharp, the Director, and Dr. H. L. Dryden, Deputy Administrator, NASA, Washington, D. C.

Several papers discussing work of the Center were presented. After lunch, attendees visited several facilities of the Center prior to adjournment in the late afternoon.

The Executive Board of the Division, at its meeting on October 19th, heard Mr. Eksergian announce his retirement as chairman and assumption of the position of chairman emeritus. The board unanimously expressed its deep appreciation of the fine leadership and devoted interest given by Mr. Eksergian throughout the life of the Division.

Jesse M. Hadley, with the Bendix Corporation, Washington, D. C., will succeed Mr. Eksergian as Division chairman. Rear Adm. M. F. Schoeffel, U.S.N. (Ret.), formerly secretary, will succeed Mr. Hadley as deputy chairman, East Coast.

The board appointed an ad hoc committee of Mr. Hadley, Admiral Schoeffel, and G. W. McBride, Union Carbide Chemicals Corporation, Washington, D. C., to process technical problems which had been received. After discussion of other subjects, the board adjourned.

Citadel Post Triples Membership With Well-Planned Series Of Activities

The enthusiastic cadets at the Citadel in Charleston, S. C., have tripled the membership of the Citadel Post and have enjoyed great activity since their fall meeting.

On October 20th the Post president, Cadet Lieut. Col. Samuel R. Bird, opened the meeting with a talk on the planned transitional change of small arms within troop units. To show this change the Post had obtained from Aberdeen Proving Ground an M14 rifle and an M60 machine gun.

Presentations were given by cadet members of the Post concerning the characteristics, employment, and nomenclature of the new weapons with Cadet Carl Erickson describing the M14 rifle and Cadet Roy H. Little the M60 machine gun. The presentations included the disassembly and reassembly of the weapons.

The members were given the opportunity to examine the weapons close at hand and ask any questions they wished of the cadet instructors while refreshments were being served.

Cadet Bird then gave a short talk on early rocket experiments and research and this was followed by a recording of the launching of the Bumper missile from White Sands Proving Ground giving the last few minutes of the countdown and the powered flight of the rocket.

On Parents' Weekend the cadets of the Post took an active part in again demonstrating the M14 and M60 weapons and preparing a display of small arms, projectiles, shell cases, and models. They also arranged to have a Lacrosse missile and launching truck brought in from Redstone Arsenal for outside display.

In November the Post sponsored a talk to the entire Cadet Corps by Capt. I. Boniface of Army Ordnance Corps—a Citadel graduate stationed at Cape Canaveral. Captain Boniface showed films on the Army's missiles; "The Polaris Story," including the tests from the submarine GEORGE WASHINGTON; and the story of Able and Baker—the two space monkeys and their voyage into space.

The final film was on missile firings

Above, left to right, Citadel Post officers Cadet Cpl. R. H. Little, treasurer; Cadet Cpl. W. M. Fambrough, secretary; Cadet 1st Lieut. A. W. Katz, vice-president; and Cadet Lieut. Col. S. R. Bird, Post president, are shown escorting Gen. Mark W. Clark, president of The Citadel, and Maj. Gen. Hugh P. Harris, commandant of the Infantry School, through the weapons display sponsored by the Citadel Post during annual Parents' Day at the college. Many modern weapons were shown.

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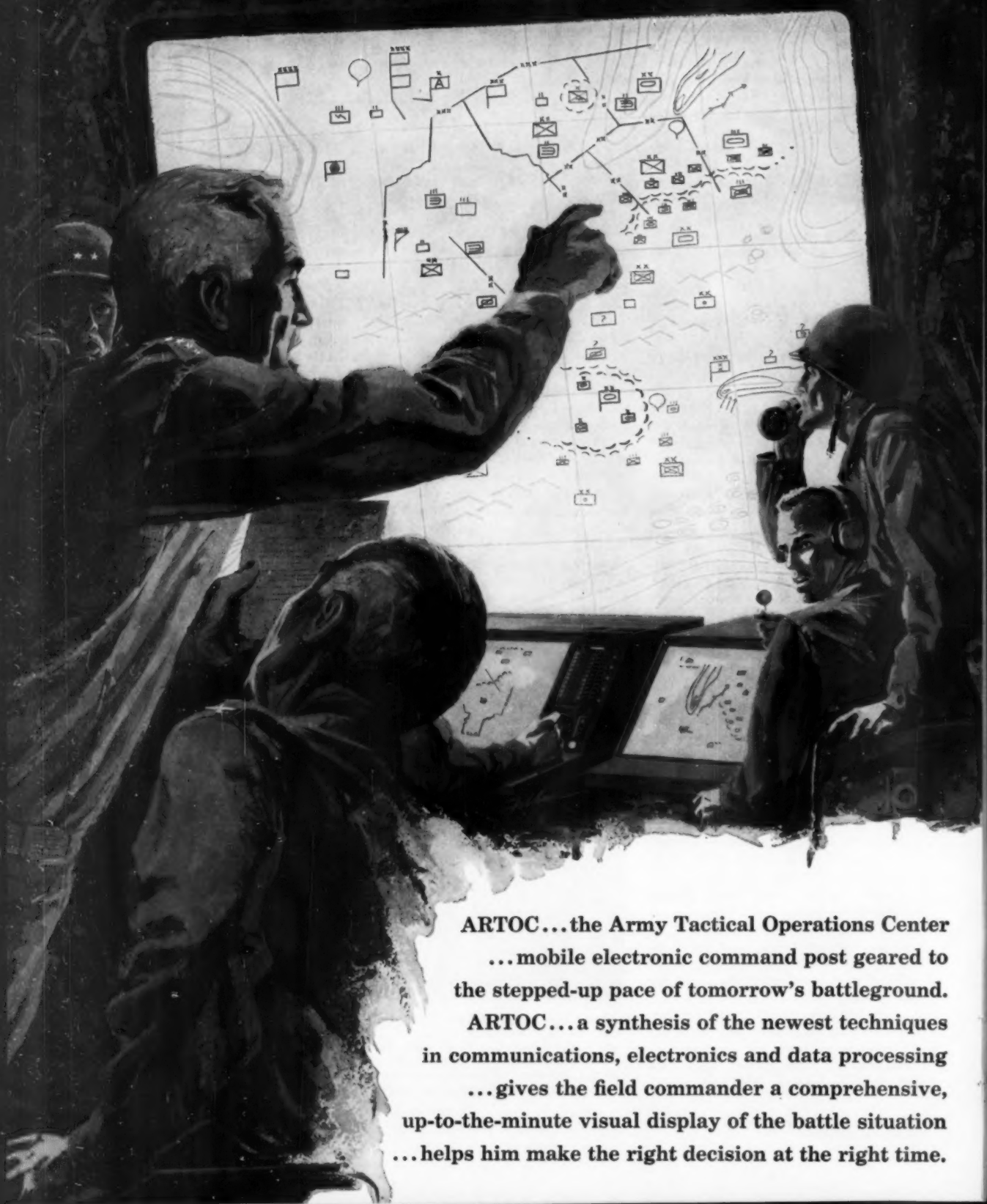

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from the Cape showing some spectacular successes and some failures. All these films were in color and all but the last was in sound.

The following day the Post made a trip to the 444th Fighter Interceptor Group at the Charleston Air Force Base where the Post members were able to get a firsthand look at the tools of defense used by the 444th.

The next evening Capt. William R. Hale, U.S.A.F., Operations Officer, 444th Fighter Interceptor Group, spoke at the Post meeting. His discussion concerned the equipment used by the 444th, the training the pilots take, and the procedure used when an alert is sounded. He described the airplanes used by the 444th and the capabilities of the F-101 Voodoo fighter which is armed with the Genie missile.

A film from McDonnell Aircraft Corporation was shown which covered the development of the Voodoo fighter and centered around its capabilities.

The December activity was scheduled to be a talk by Arthur M. Wilcox, a student of the Civil War.

Los Angeles Post Members "Join The Navy" For Cruise Aboard Aircraft Carrier

The Los Angeles Post members "joined the Navy" on October 10th on an all-day cruise aboard the U.S.S. KEARSARGE (CVS-33), commanded by Capt. P. W. Jackson, U.S.N. The KEARSARGE is the flagship of Rear Adm. Robert L. Townsend, Commander, Carrier Division Seventeen.

"The Mighty Kay," which recently returned from a 6-month tour with the Seventh Fleet in the Far East, is one of the four modern antisubmarine carriers operating on the West Coast.

A.O.A. members were given technical briefings on the various departments aboard the ship and witnessed carrier

Capt. P. W. Jackson, KEARSARGE commander, left, receives a check for Navy Relief from A. E. Austin, Jr., Los Angeles Post president, and Frank Mayer, vice-president.

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air operations. The members also enjoyed the excellent Navy chow and the steady availability of hot coffee.

Special Recoilless Rifle Committee Is Organized At Frankford Arsenal, Pa.

Based upon the request received from the Chief of Army Ordnance, preliminary work by the A.O.A. resulted in organizing a meeting for the Special Committee for Recoilless Rifles and Ammunition Systems at Frankford Arsenal on November 15th.

This special committee will assist Col. A. R. Cyr, who is Commanding Officer of Frankford Arsenal and also assistant manager for Recoilless Rifles and Ammunition Systems.

After a welcome by Colonel Cyr and a discussion on the objectives of the special committee, George Schecter, John J. Donnelly, Jr., and Henry S. Lipinski, all of Frankford Arsenal, discussed the present and future programs of recoilless weapons.

Mr. Schecter used eight sample problems as a basis for discussion on the type of assistance the special committee could give the assistant manager. These problems in general are detailed technical problems and concern many phases of recoilless technology, including the area of materials.

The discussion pointed out that the special committee utilizes the capabilities of other A.O.A. Divisions and Sections to give useful support on problems presented. There is an additional capability in the committee to deal with systems-type problems such as correlation between the gun tube and ammunition or the mount and its related fire control.

Henry Handler, Office, Chief of Army Ordnance, discussed processing of problems requiring written reports from A.O.A. It was decided that Frankford Arsenal will complete the presentation of certain problems and forward these to the Chief of Ordnance.

The Division chairman and representatives of OCO and A.O.A. headquarters will review these problems and determine how they will be handled.

They then will be sent to suitable committees for initial action prior to the next meeting of the special committee. It is anticipated that the special committee will meet during the latter part of January.

Col. Henry N. Marsh, A.O.A. vice-president for technical Divisions, announced the appointments of Dr. C. S. Cummings, Remington Arms Company, Bridgeport, Conn., as chairman of the special committee, and A. R. Metzger,

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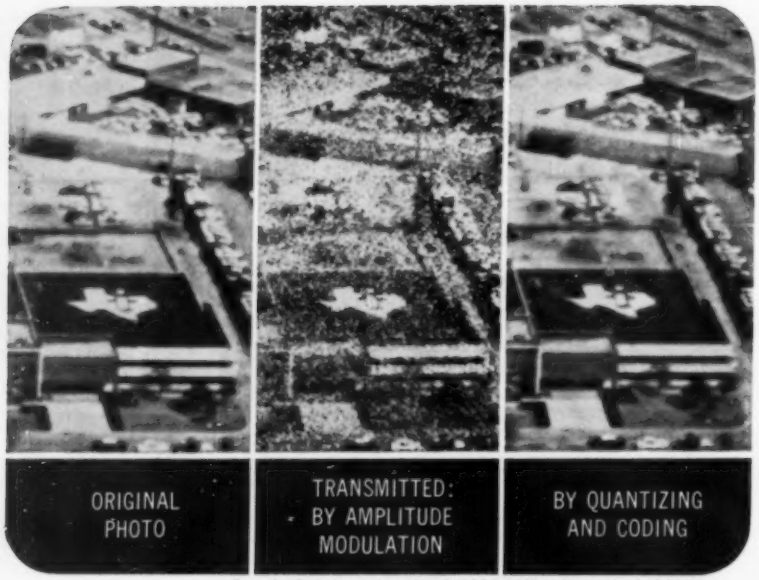

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Association Affairs (Contd.)

Bethlehem Steel Company, Bethlehem, Pa., as deputy chairman.

A secretary will be appointed at an early date. Colonel Cyr and Colonel Marsh reiterated the importance of the recoilless-rifle field and the value of the support that can be given by this new special committee.

Aberdeen Post Members See High-Speed Mass Production At General Motors Plant

"Modern, automated, high-speed mass production" was the theme of this year's first meeting of the Aberdeen Proving Ground Post on Wednesday, November 16th. The group visited the Fisher Body and Chevrolet Assembly Plant Divisions of General Motors Corporation in Baltimore to view the development of an automobile from stockpile, through assembly line, to finished vehicle.

Facilities of the plant limited the crowd to the 160 members who assembled in the plant cafeteria for dinner before they were divided into smaller groups for the plant tour. At the dinner, Post President Charles D. Nitchie welcomed the members and on their behalf thanked the local General Motors management for its hospitality.

Dr. H. Guyford Stever Is Awarded The Scott Medal For Guided-Missile Work

Dr. H. Guyford Stever has been awarded the Association's Scott Gold Medal for his outstanding contributions to the Nation's guided-missile programs. Association President Louis Polk presented the medal to Dr. Stever at a banquet of the Missiles and Astronautics Division in Cleveland on October 20th.

Dr. Stever, professor of the Department of Aeronautical Engineering, Massachusetts Institute of Technology, Cambridge, Mass., has long been prominent in top scientific circles. In addition to other committees he has been, since 1947, a member of the U.S.A.F. Scientific Advisory Board and its vice-chairman since 1956.

From 1955 to 1956, he was chief scientist of the Air Force, and was the recipient of the Air Force Exceptional Service Award for his excellent work. Dr. Stever has conducted research chiefly in the fields of cosmic rays, radar, guided missiles, high-speed aerodynamics, high-speed flight, and nuclear-powered aircraft.

Following the award, Dr. Stever addressed the members and guests of the

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Association Affairs (Contd.)

Missiles and Astronautics Division on the impact of space science upon many facets of modern life.

Groundwork Is Laid For Organizing A Special Value Engineering Group

On October 12th a meeting was held of the Steering Committee for Organization of the Special Committee for Value Engineering. W. R. Gourley, Philco Corporation, Philadelphia, Pa., Committee chairman, headed the meeting of members and consultants.

Discussion initially concentrated upon the need for full representation from the A.O.A. technical Divisions.

It was decided to hold a meeting on January 11, 1961 (later changed to January 12th), at which the chairman would present a proposed statement of the mission and scope of effort for the Committee. Consideration was next given to the establishment of subcommittees with the following titles: (1) Motivation, (2) Education, and (3) Technical.

In addition to these probably standing subcommittees, ad hoc committees may be designated to handle specific problem matters and to prepare and submit reports to the over-all Committee and to the technical Divisions concerned.

Capt. G. S. Morrison Speaks To Members Of Tri-Cities Chapter At Binghamton, N. Y.

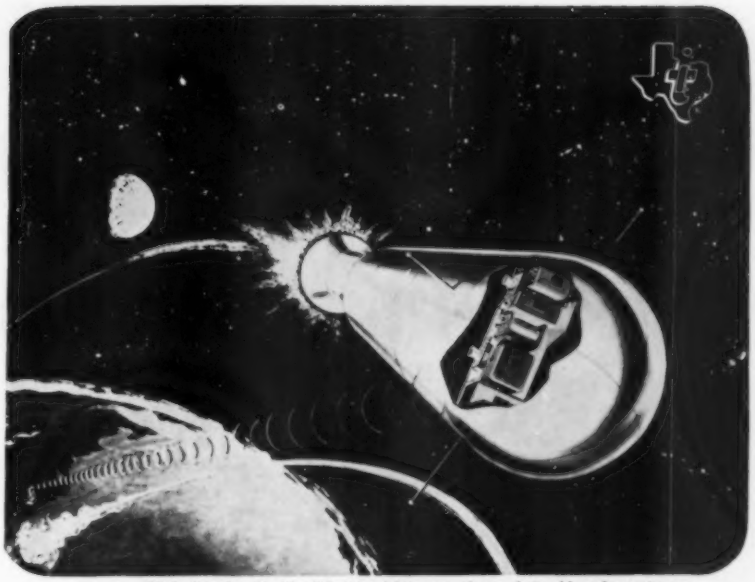
The ever-active Tri-Cities Chapter of the Empire Post was host to Capt. G. S. Morrison, head of the Space Programs Branch, Office, Chief of Naval Operations, on October 13th at a dinner meeting at the Binghamton Country Club.

Captain Morrison covered the history of space explorations beginning with the early rocketry of Dr. Goddard prior to World War II. He pointed out the complacency that existed in the United States in the years following and how the Germans really opened up the field again during World War II with the V-1 and V-2 series of rockets. He briefly covered the steps taken by the United States following World War II in first adapting and improving the V-2 rocket and then proceeding to newer original designs.

Captain Morrison next covered the dramatic successes of the Russians with their Sputniks and Luniks. He pointed out that their programs seemed to be following a "three-of-a-kind" series and speculated that a manned orbiting flight was imminent.

Following the history of rockets and space ships, Captain Morrison presented the Navy's twofold role in space: *i.e.*, those items which are directly applicable to the fleet and, secondly, those areas in which the Navy supports other services or agencies. He elaborated on these two aspects by noting that satellites orbiting the earth can provide significant advances in navigation and communication as they pertain to our fleet of ships. Providing support in the form of launching platforms, tracking stations, and recovery operations is a major effort of the Navy to the Air Force, Army, and NASA.

Throughout his address Captain Morrison stressed the importance of mobility —something the Navy is in a better position to provide than any other of the services.



TI designed and built solid-state uhf transponder made tracking of recent space probes beyond skin range possible, without waiting for down range reports.

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Standards And Metrology Executive Board Meets At Sandia Corporation, N. Mex.

The Executive Board of the Standards and Metrology Division met at Sandia Corporation, Albuquerque, N. Mex., in early October to plan Division activities and the sixteenth annual Division meeting to be held February 15-16, 1961.

Chairman C. Thorpe Thompson, Sheffield Corporation, Dayton, Ohio, led the Planning Section in discussing proposed activities, and the theme "Modern Metrology and Weapons Production" was selected for the February meeting.

Proposed papers will describe Defense standardization policies, the technical operations of the National Bureau of Standards, and electronics and dimensional metrology.

The Board was joined by representatives of Sandia Corporation and the detailed program was worked out. Upon adjournment of the planned meeting, the board visited Sandia's Primary Standards Laboratories and later joined the Albuquerque Post for its fall dinner meeting.

Executive Board Of A.O.A. Artillery Division Hears Reports At Pentagon Meeting

The Executive Board of the Artillery Division convened at the call of Chairman J. L. Auer, president, R. Hoe & Co., Inc., New York, N. Y.

The meeting was held at the Pentagon on October 18th and received reports from committee chairmen. Maj. Gen. E. P. Mechling, U.S.A. (Ret.), reported upon the results of the technical documentation survey that had been made and also upon the results of the Value Engineering Committee meeting. Emphasis was placed upon the interdivisional aspects of these subjects which have led to the creation of special committees.

Col. René R. Studler, U.S.A., (Ret.), Washington, D. C., reported on the formation of the Special Committee on Recoilless Rifles and Ammunition Systems.

Following the discussion of the processing of ordnance problems being submitted to A.O.A. Divisions, given by Henry Handler, Office, Chief of Army Ordnance, Washington, D. C., the board discussed plans for a meeting to be held in the spring of 1961.

Alternative sites were selected and approved and the chairman authorized to make the final arrangements.

Admiral Weakley Outlines ASW Problem At Hartford-Springfield Post Meeting

The Navy's undersea-warfare problem was skillfully presented by Rear Adm. Charles Weakley, Commander, Destroyer Force, Atlantic Fleet, to the Hartford-Springfield Post on November 7th.

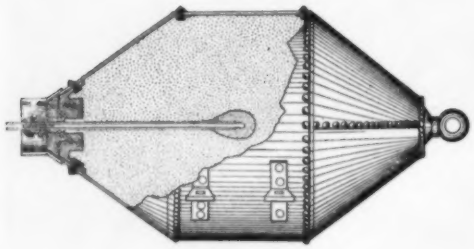
Members from as far north as Greenville, Mass., and from Bridgeport to the south gathered at the Statler-Hilton Hotel to welcome Admiral Weakley.

J. Alan MacDonnell, Post president, opened the meeting, heard a business report from Maj. C. W. Emmons, Post secretary-treasurer, and announced the names of the officers nominated by the Post's board of directors.

The new slate was unanimously approved and the three new vice-presidents introduced—Robert S. Harper, United-Greenfield Corporation; Dr. Philip H. Burdett, Remington Arms Company; and John F. Smith, United Aircraft Corporation. The president-elect, Fred A. Roff, president of Colt's Patent Firearms Manufacturing Company, was unavoidably absent. Mr. MacDonnell then offered a memorial resolution for two greatly revered members of the Post who had died since the previous meeting—Col. F. H. Payne, formerly Post president and a member of the Association's Board of Directors, and Col. William J. Crow.

(*Continued on p. 532*)

No. 3 in the series of A.O.A. monographs on Civil War armament



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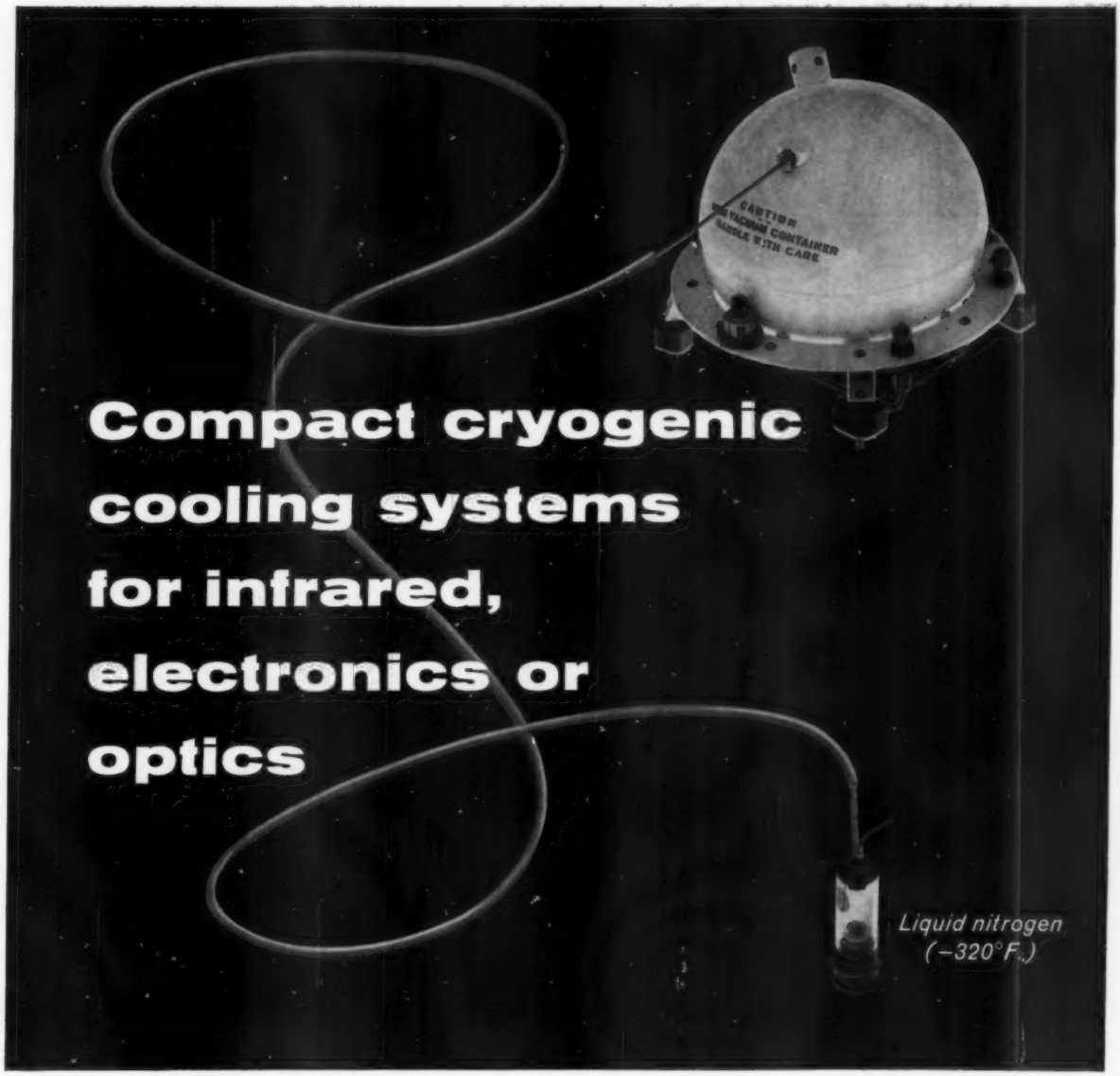

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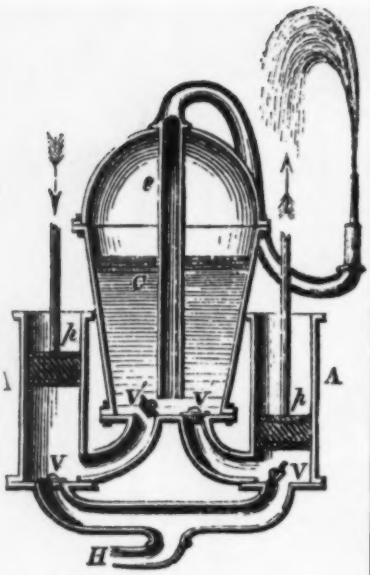

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Association Affairs (Contd.)

Post secretary-treasurer at the time of his death and an active participant in A.O.A. affairs for many years.

An A.O.A. medallion was presented to Alan MacDonnell by Capt. J. M. P. Wright of A.O.A. headquarters who read the citation recounting in part:

"Mr. MacDonnell, a member of the Association for over a decade, served continuously for twelve years as secretary-treasurer of the Hartford-Springfield Post and for the past three years as its president. Throughout this long career he has maintained a high degree of interest and a noteworthy standard of performance in Post activity.

"This award denotes the admiration and gratitude of all officers and members of the Association and conveys their sincere wishes for continued happiness and success."

Admiral Weakley not only covered his subject, "The Antisubmarine Warfare Problem," in a masterful manner but defined clearly the vital importance of our naval forces, noting that "the Navy has to do its job before the Army and Air Force can do theirs."

He explained that the United States has a military "shield" overseas in that we have established forces within approximately forty friendly areas and to support them requires shipping defended by strong naval forces.

The admiral reviewed, with slides, the aircraft, surface ships, and submarines that are all an essential part of the ASW team—each one with a special capability to defeat the modern nonnuclear sub many times more effective than World War II types. He showed that although it required a two-to-one preponderance in surface ships and five-to-one in aircraft to halt the German submarines in the last war we now have let our forces dwindle relative to Soviet subs to a disturbingly smaller ratio.

In weaponry, Admiral Weakley outlined in broad terms the range increases made in underwater detection that greatly surpass the effective range of underwater ordnance. He challenged the Ordnance Association members to work harder to perfect such weapons.

In closing, he demonstrated the comparative tonnage that can be carried by all available air transport—represented by a narrow piece of cardboard—and the amount that can be carried in ships—a roll of ribbon many yards long.

Dixie Post Holds Meeting To Organize New A.O.A. Chapter At Richmond, Va.

The planning and organizing groups for a new Chapter to be established in Richmond, Va., launched into operation on Tuesday, November 1st, when industrial leaders of Richmond met with officials of the Dixie Post to discuss the procedures and to set up the necessary working committees.

The host for this momentous occasion was the Reynolds Metals Company which had offered the conveniences of its restaurant in its sparkling new aluminum and glass headquarters building on the outskirts of Richmond. Chairman of the meeting was Thomas L. Fritzlen, chief metallurgist of Reynolds Metals Company and a director of the Dixie Post. In support of Mr. Fritzlen from his company were W. M. Wells, C. L. Manning, and Capt. Murray W. Clark, vice-presidents of the company.

Other Richmond men present were E. L. Kern, Richmond Engineering Company; Jerry A. Burke, Jr., Experiments, Inc.; Col. Frank G. White, Commandant, Logistics Management Center, Fort Lee, Va.; Col. Charles L. Seigle, Logistics Management Center, Fort Lee, Va.; Capt. W. G. Blasdel, S.C., U.S.N., Quality Control Center, Camp Bellwood, Va.

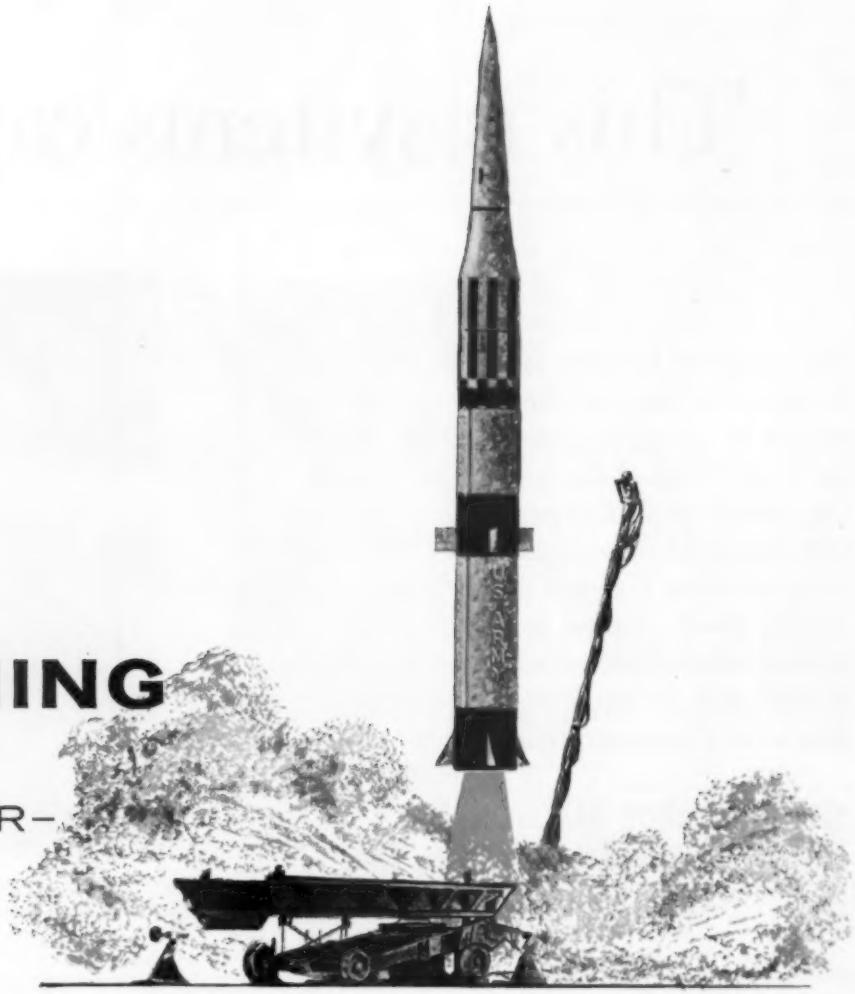
The Dixie Post contingent was led by its president, H. C. Duncan, assisted by Dr. U. Cormier; George Svadeba; A. J. Friedhaber; and Lyn P. Wallace.

Mr. Fritzlen called on Capt. J. M. P. Wright from national headquarters to explain the reasons for establishing Chapters and to discuss the manner of their organization. Mr. Duncan welcomed the assemblage on behalf of the Dixie Post and expressed the hope that the Chapter would grow rapidly to Post stature, while Dr. Cormier presented the view that in the Richmond area there was a tremendous potential for effective Association work.

Mr. Svadeba, charter president of the Dixie Post who was instrumental in its organization, said that the most important consideration was that the Chapter provide activity that industrial men cannot get otherwise.

After a general discussion, Mr. Fritzlen was appointed unanimously as the chairman *pro tem* of the Chapter. He immediately appointed Colonel White as chairman of the program committee and himself as the chairman of the nominating committee.

It was agreed that the assembled Richmond members would act as a membership commitee to urge men of the industries of Richmond and individuals to flock to the A.O.A. standard. (*Contd. on p. 535*)



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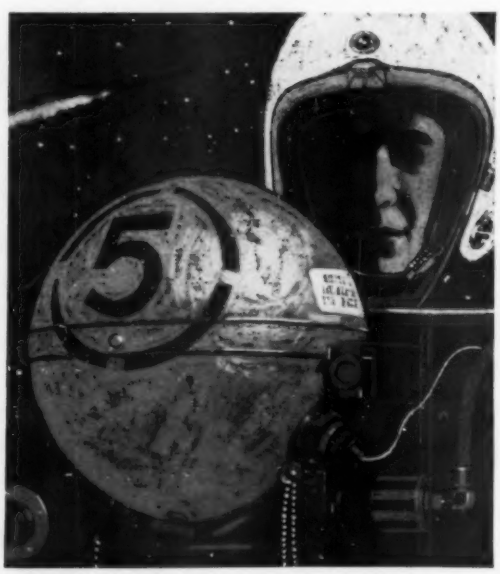

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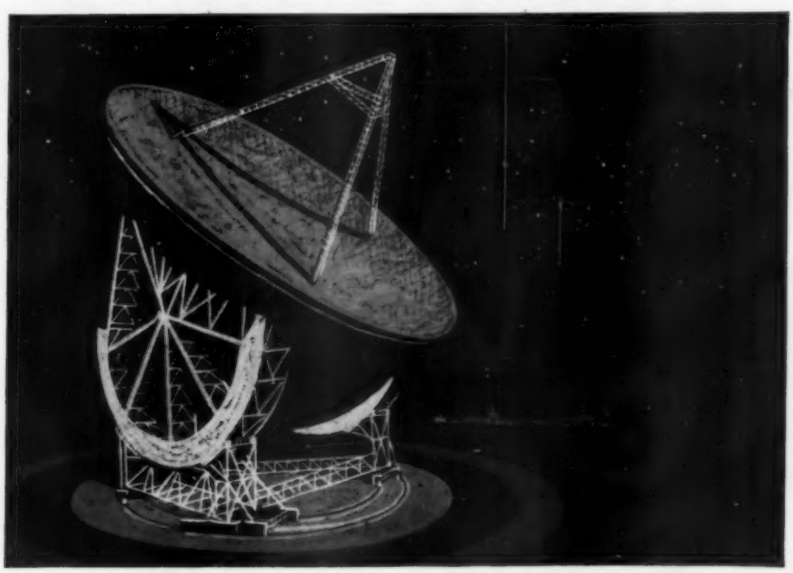


THE BIG "EAR." The world's largest radio telescope reflector, 600 feet in diameter and more than seven acres in area, is being built by the Columbus Division for the U.S. Naval Radio Research Station in Sugar Grove, West Virginia. The 10-foot thick movable reflector will have a potential range of billions of light years.

"The Submarine of Today and Tomorrow" was the subject that Lieut. Comdr. John F. Fagan, Jr., discussed at a fall dinner meeting of the Dixie Post at the Officers' Club at Fort Eustis, Va. Commander Fagan is the commanding officer of the nuclear-powered submarine SHARK (SS(N)591) undergoing extensive dock trials at the Newport News Shipbuilding and Dry Dock Company. The SHARK's keel was laid on February 24, 1958, and it was launched on March 16, 1960.

Col. M. H. Clark Addresses Panhandle Chapter Members At Amarillo Air Force Base

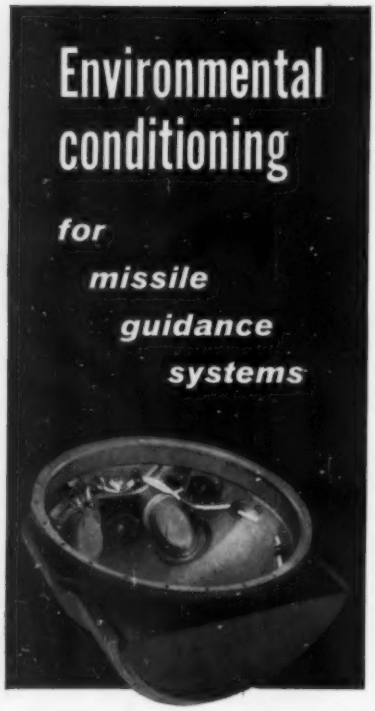
Col. Milton H. Clark, U. S. Army, Operations Officer, White Sands Missile Base, was guest speaker at the meeting of the Panhandle Chapter of the Mid-Continent Post held at the Amarillo Air Force Base Officers' Club, Amarillo, Tex.

Chapter President M. E. Shaw presided, and W. W. Ward gave the invocation. Colonel Clark's talk was based on "Missile Testing at White Sands," and included an informative color film taken of actual operations and testing problems at White Sands. His talk pointed out that the testing agency for the Army Ordnance Missile Command runs one of the three national testing ranges used in the development of new missiles.

Colonel Clark noted that Cape Canaveral is administered by the Air Force and the Pacific Range by the Navy while White Sands is the only overland range that is a testing agency for the Army, Navy, and Air Force. It has an advantage over sea ranges as it provides latitude for better instrumentation and recoverability of missiles.

He described operations explaining that weekly forecasts are made but that exact schedules are set up a day in advance for all types of missile testing, including testing of guidance equipment. There was a question-and-answer period following Colonel Clark's talk and showing of the film. The lively discussions that ensued indicated the great interest of the members in missile-testing problems and other facets of offensive and defensive modern armament. Special recognition was given to Mason & Hanger-Silas Mason Company whose general manager, John C. Drummond, was host during the social hour on behalf of his company. The Chapter president, Milton Shaw, reported that the membership of the Amarillo Chapter now totals well over one hundred. The Chapter is continuing its efforts to obtain new members and is planning shortly to circulate a petition requesting Post status.

(*Continued on p. 536*)



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Rear Adm. P. D. Stroop Is Honor Guest At Special Meeting Of The Dixie Post

Rear Adm. P. D. Stroop, Chief of the Bureau of Naval Weapons, as guest of honor at a Dixie Post special fall meeting, spoke to the members on "Naval Weapons—Flexible Force for Freedom." The Navy's ordnance chief displayed by colored slides the full panolpy of modern naval weapons accompanied by his own crisp commentary.

An artistic view of the recently launched nuclear carrier FORRESTAL and the aircraft she will carry led the procession. Then in action were shown the destroyer antisubmarine helicopter (DASH) working from a destroyer, the Asroc surface-to-underwater missile being fired from the destroyer leader NORFOLK, and the Bumble Bee family of missiles—the Terrier, Talos, and Tartar—developed by the Applied Physics Laboratory of Johns Hopkins University.

The admiral also had sketches of the underwater missile, Subroc, under development that will be fired under water, take to the air, and then slide underwater before striking the target.

Air-to-air missiles displayed were Bullpup, Sidewinder, and Sparrow. The admiral expressed his pleasure with the first two missiles because they require no more special treatment in storage than a round of conventional ammunition.

In reviewing slides of the Polaris fleet ballistic missile, Admiral Stroop stressed that the entire system—launcher, missile, and fire control—received its final test at sea, where it will be used, and by the crew who would be required to use it in action.

The final shot was Lulu, the Navy's underwater atomic weapon, mostly hidden by a model posed on top of it!

In preliminary activities Comdr. B. C. Barrett, Chaplain of the Naval Weapons Station, Yorktown, Va., gave the invocation. H. C. Duncan, Post president, called an Capt. J. M. P. Wright for a report from national headquarters of the A.O.A. and then introduced L. R. Sorenson, vice-president and general manager, Newport News Shipbuilding and Drydock Company.

Mr. Sorenson delivered a friendly good luck message in honor of Rear Adm. O. D. Waters, Jr., a director of the Dixie Post who is being detached as commander of the Naval Weapons Station for sea duty in the Far East, and presented the admiral with a souvenir cigarette lighter from the members.

Admiral Waters introduced the guest of honor who was also presented with a membership in the Association.

Statistics Show Association Progress During Year 1960

A review of Post statistics shows that the year 1960 has been the most active in the history of the Association. Eighty-six meetings were held altogether by the forty-one Posts and fourteen Chapters. These included 71 luncheon or dinner meetings, 8 visits to defense activities, 2 visits to industrial plants, 4 seminars in ordnance or technical fields, and the annual golf tournament in Washington, D. C. (*Continued on p. 538*)

Shown above at a recent San Francisco Post meeting are, left to right: Vice Adm. F. N. Kivette, Commander, Western Sea Frontier; E. Finley Carter, Post president; Vice Adm. William F. Raborn, Jr., director of the Polaris weapon system, the principal speaker; and Maj. Gen. G. C. Mudgett, Deputy Commanding General, Sixth U. S. Army. Admiral Raborn is shown holding a model of a Polaris-firing submarine.

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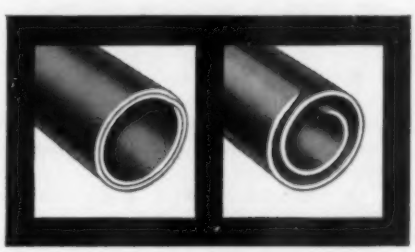

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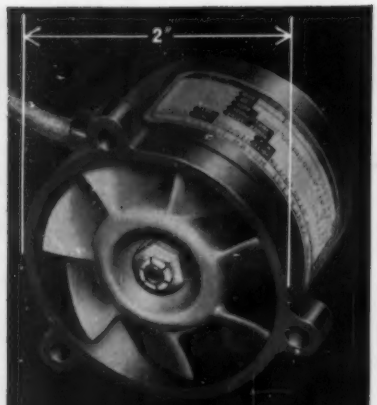

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AiResearch Minifan* is an extremely high performance 400-cycle AC motor-driven fan used for cooling airborne or ground electronic and electrical equipment. Model shown has a flow capacity of 53.5 cfm at a pressure rise of 3.44 H_2O, and requires only 69 watts.

Minifan operates up to 125°C. ambient. Its size and weight make it ideal for spot cooling, cold plates or as a cooling package component. The fan can also be repaired, greatly increasing its service life.

Range of Specifications

- Volume flow: 21.5 to 53.5 cfm
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A world leader in the design and manufacture of heat exchangers, fans and controls, AiResearch can assume complete cooling system responsibility. Your inquiries are invited.

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Shown above, left to right, are Louis Polk, president of the Sheffield Corporation; Dr. Allen Astin, Director of the National Bureau of Standards; and Dr. Elmer Hutchisson, Director of the American Institute of Physics, who constituted the U. S. delegation to the International Conference on Weights and Measures in Paris, France. The group is shown examining a comparator used to measure the French platinum-iridium bar, formerly the world's standard of length, now replaced by 1,650,763.73 orange-red wave lengths of an atom of the gas, krypton 86.

• DR. W. R. G. BAKER, a leader in the development of the television industry and a pioneer in radio, died in his home in Syracuse, N. Y., on Sunday, October 30, 1960.

He had been a member of the Association for years and was a leader in the technical Divisions. Dr. Baker was president of the Syracuse University Research Corporation. He was named vice-president for research of the university in 1957 when he retired as vice-president of the General Electric Company.

The company's pioneer television station at Schenectady uses Dr. Baker's initials, WRGB, as its identification, in recognition of his contributions to the development not only of the company but also of the television industry as a whole.

The scientist graduated in 1916 from Union College, later receiving a master's degree and an honorary Doctor of Science degree. He joined General Electric's research laboratories in 1917 and took a prominent part in the development of wartime radio. As the company's effort in this field increased, a radio department was established, and Dr. Baker was made designing engineer in charge of transmitters.

On formation of RCA Victor Corporation in 1929, Dr. Baker went to Camden, N. J., to head radio engineering activities. Later he became vice-president and general manager. In 1936, when General Electric resumed its radio receiver work, Dr. Baker returned to the company as managing engineer in Bridgeport, Conn.

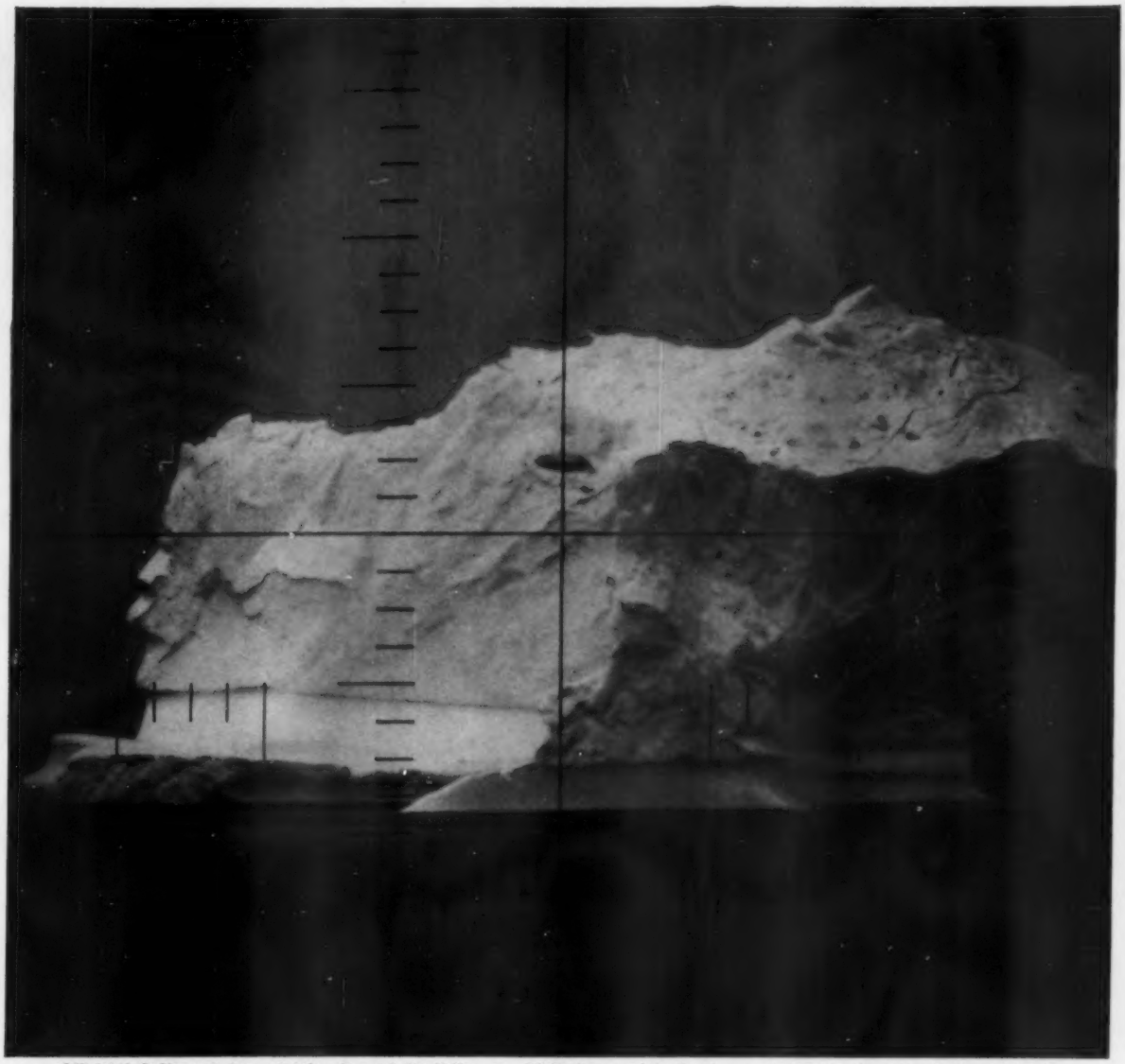
In 1939 he was named manager of the company's radio and television department, which subsequently was redesignated the electronics division. In 1941 he was named a vice-president of the company.

For his work during World War II, Dr. Baker was honored by both the Army and Navy. The War Department cited him for contributions to the development, design, and production of the complex Signal Corps radar and radio equipment. He also was cited for services to the military during the Korean conflict. He received the Army's Medal of Freedom in 1953.

After the war, Dr. Baker concentrated on the development and production of television and frequency-modulation broadcasting and receiving equipment. Under his direction as chairman of the National Television Systems Committee, the standards for black and white televising were developed, recommended, and adopted by the Federal Communications Commission. He also served as chairman of a second television systems committee which recommended color television standards that were accepted by the Commission.

In his service on the United States Army Scientific Advisory Panel he contributed his vast knowledge of electronic phenomena in pointing the way to the development of many of the devices now employed in communications and reconnaissance by our forces in the field.

Dr. Baker received the Medal of Honor of the Institute of Radio Engineers in 1952 and the Medal of Honor of the Radio-Electronics-Television Manufacturers Association the next year.



Official U. S. Navy photograph taken through the Kollmorgen 8B Periscope of the Seadragon during its polar cruise in August, 1960.

1,000 miles out to see

Long, lonely reaches of the sea are prowled by our sentinel submarines . . . scanning the endless surface, listening and looking for signs of man. Kollmorgen periscopes, standard with the United States Navy including submarines of the atomic fleet, are highly sophisticated electro-optical systems delivering dependably clear viewing, photography and navigational data under the most severe conditions.

The talents and facilities which produce these periscopes are continuously developing many other products involving optics, mechanics and electronics. For instance, Kollmorgen hot cell and underwater periscopes permit remote viewing and photographing of radioactive material in nuclear installations. Continuous-strip cameras can now photograph the length of a moving track, entirely enclosed except for access as small as $\frac{1}{32}$".

When you are seeking creative solutions to problems in areas such as remote viewing, testing, inspection, alignment . . . look to a proven source. A new brochure discusses Kollmorgen's facilities and fields of interest.

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FROM THE RECORD

Challenge to Management

THE services seek maximum competition when contracting for a weapon or a component. We are constantly looking for new ways to tighten up negotiation and pricing and to improve their quality. The question is, are you in industry doing an equally vigorous job? Are you exploiting to the utmost the element of competition among your prospective suppliers? Or do you simply accept a proposal and reflect its cost in your final price?

Each time examples of uneconomical practices have become apparent to us, we have taken steps to plug the hole. Recently, the Armed Services Procurement Regulation was changed to give the contracting officer greater control over the primes' make-or-buy decisions. This change was a direct reflection of the fact that the services had lost confidence in the objectivity of some—repeat, *some*—of their contractors in deciding make-or-buy questions.

The solution is in your hands. You must exploit competition, price closely, and decide to make or buy on the basis of real economy to the Government.

Another area where we are asking all our contractors to be lean and hard is in overhead and administrative expenditures. The previous Armed Services Procurement Regulation and the new Section 15 Cost Principles measure the allowability or nonallowability of many of these types of costs against the test of "reasonableness." We have decided that in many cases what might have seemed "reasonable" five years ago, or even last year, just does not pass the test today.

For example, in 1957 there were 341,000 production workers in the aircraft and parts industry. In February 1960, there were 240,000. Some companies have suffered drastic reductions, even as high as sixty-five per cent of their production workers. But we are still a long way from realizing equivalent reductions in overhead expenses. . . .

In the issuance of the new Section 15 on Cost Principles in the Armed Services Procurement Regulation, a new approach was made to costs for research and development. The new plan was worked out after much discussion with industry and with interested officials of the Department of Defense. It has two purposes. First, it clarifies the very limited coverage of its predecessor. Secondly, it is intended to encourage general research.

These new cost principles were not—and I repeat, *not* intended to open the floodgates. Rather, they were to recognize the value of basic research in industry and the benefits which can accrue from increasing emphasis on basic research. However, if you have been charging research to defense contracts costing, say, $500,000 annually, you cannot expect to come in now and say, "We are going to charge you $10 million next year." This is not "reasonable," and we will not allow the charge.

Another facet of cost that we must be chary of is construction of facilities. We do not suggest that you operate from shacks, but facilities shouldn't be personal monuments, either.

One of our recent discoveries while we have been casting about for ways to save money was the fact that the services annually spend $1.5 billion for technical data and drawings, and half a billion dollars for their reproduction. The services receive 6 million new or revised prints each year, and file 50 million drawings. They distribute a billion prints. . . .

We know that we can save a great deal of money by more discriminating purchase of drawings. We are instructing our people accordingly. This is an area where you as contractors can be helpful by questioning any requirements that seem to you to be unreasonable.

I HAVE referred to the questioning of requirements by industry, and this brings me to one of my most important points. You in industry and we in the services are on this defense team together. No one has an exclusive right to the bat or the ball. If a contractor discovers what he considers to be an unnecessary or duplicative design requirement, and if eliminating this requirement would reduce the cost of the item without impairing its combat potential, I think that that contractor has a moral responsibility to bring this fact forcibly to the attention of responsible service officials.

If substantial savings are involved, he shouldn't give up at the first rebuff. Let's face it—project officers and engineers are frequently so wrapped up in their programs that it is difficult for them to back off and see the larger picture, especially if it appears that someone is questioning their own judgment. Let me assure you that the Bureau Chiefs are extremely interested in all worth-while suggestions, and so am I.—HON. CECIL P. MILNE, *Assistant Secretary of the Navy (Material), before the Washington Post of the American Ordnance Association, Washington, D. C.* *(Continued on p. 542)*

a flexible, dynamic approach to propulsion and ordnance

Amcel is an organization of specialists and special facilities, dedicated to second generation exploration and innovation in the fields of propellants, explosives, and related technologies. It is fully staffed and equipped for independent and contracted research and development programs, and pilot production.

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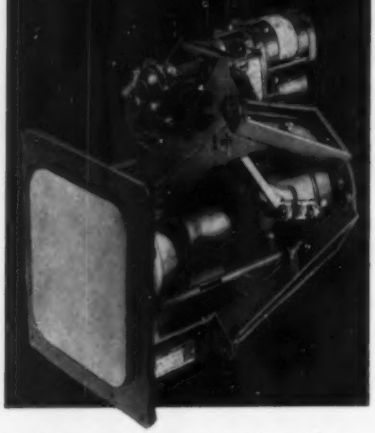

This ram air scoop is another example of AiResearch's ability to design and integrate structural and electromechanical systems for control functions.

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Arms and the Cost

WE deal on a day-to-day basis with the weapons and munitions that may mean life or death to our troops and victory or defeat to our cause. We must have the best equipment that can be provided to the combat arms, to our sister services, and to our allies abroad. Ordnance has a singular and indivisible responsibility to the Army and the country. It is assigned by law and regulation and by moral precept. We cannot share it with industry. But we can and do place upon industry our primary reliance for quantity and quality production of the materials of war. And on our scientific colleagues we place great reliance for new ideas, for the basic and supporting research that must be the well-spring of progress.

The procurement of weapons, tanks, combat vehicles, and other Ordnance items requires substantial investment. We are currently managing the expenditure of approximately $3 billion annually. This supports research and development, production and procurement, the training of troops and support in the field of the systems we supply to the combat forces. And *that* is our reason for being.

In that light I think you will agree that a very modest amount is retained—on the order of ten per cent—for the activities carried on within Ordnance itself in the research, development, production engineering, pilot production, inspection, and testing of new items. This work is conducted in the Ordnance system, made up of research and engineering laboratories, commodity commands and arsenals, procurement districts, proving grounds, and depots.

We are not dealing with washing machines or sports cars. We are dealing with the rugged and reliable tools which mean life or death on the battlefield. The modern Army depends upon us to provide these tools that are needed to win any struggle in which it is engaged, regardless of its scope, wherever and whenever it may occur. Obviously, to be of any use, those weapons must be backed up by reserve stocks in the Ordnance supply system. . . .

Currently we are spending about forty-five per cent of our dollars on the procurement and production of weapons—the ones we could use tonight, or next week, or next year. Another twenty-one per cent of our dollars is going into the research, development, and engineering of weapons that we would use three or more years from now.

On the question of balance between the exotic and the conventional, about 70 per cent of the foregoing is being invested in missile systems while about 30 per cent supports the development and procurement of conventional arms and ammunition, tanks, and other items. If you asked whether that apportionment is exactly right, I can only answer that it represents the best judgment we could bring to bear on the problem. I believe we cannot afford to decrease the actual dollars going into missiles and rockets, but I also believe we must put more actual dollars into our conventional weapons. I think we may move in that direction in next year's budget.—LIEUT. GEN. JOHN H. HINRICHS, *Chief of Ordnance, United States Army, before the Cleveland Post of the American Ordnance Association, Cleveland, Ohio.*

Weight in Space

OUR preoccupation with weight in the space programs led us to a very broad analysis of what one might do to achieve very light weight. For example, a study was produced by the Rand Corporation in December 1957 which analyzed the many possibilities to achieve power on the basis of watt-hours per pound. As a point of departure, Dr. Huth of Rand pointed out that currently available nickel-cadmium batteries which have been used extensively for guided missiles and satellite power sources could produce about 15 watt-hours per pound.

I suspect that this criterion for judgment as to effectiveness of a particular power source does not ring a bell with you. For comparison, let's look at watt-hour output per pound of a fairly conventional portable generator. We have a 70-kw. gas-turbine generator in development for which we predict a weight of only a few hundred pounds. If one completely ignores the weight of fuel which would have to be provided to operate such a generator, it is apparent that this generator will have an output of literally hundreds of watts per pound.

That looks pretty good until one computes the weight of fuel required for any reasonable period of operation. The requirement to carry fuel quickly destroys any advantage that such a generator might have. . . .

At this point in time, the power source most used for satellite applications requiring any appreciable effective life is the solar cell. The answer is perfectly obvious. The fuel supply is available as long as the satellite is not in the shadow of the earth. Unfortunately, most practical applications for vehicles in orbit result in some time in shadow. Consequently, most present satellite vehicles are powered by a combination of batteries and solar cells. The most effective of these to date require something in the order of 0.5- to 0.7-pound per watt capacity to be provided in orbit. Lifetime is limited only by reliability.—BRIG. GEN. AUSTIN W. BETTS, *Director, Advanced Research Projects Agency, Department of Defense, before American Society of Civil Engineers, Kansas City, Mo.*

Tailoring new re-entry materials with a white-hot needle. This is a 10-megawatt arc jet "needle." Avco uses it to test heat-shield materials under simulated re-entry conditions. Avco has capabilities for developing new materials to meet whatever thermal environmental conditions may be encountered by a re-entering nose cone, satellite or space probe. Examples: Avcoite, reinforced-quartz protector of the first ICBM nose cone recovered after flight . . . Avcoat, special all-plastic formulation which can be cast, sprayed or painted on. Other exotic materials are on the way as Avco tailors new ceramic-plastic composites to surmount re-entry obstacles.

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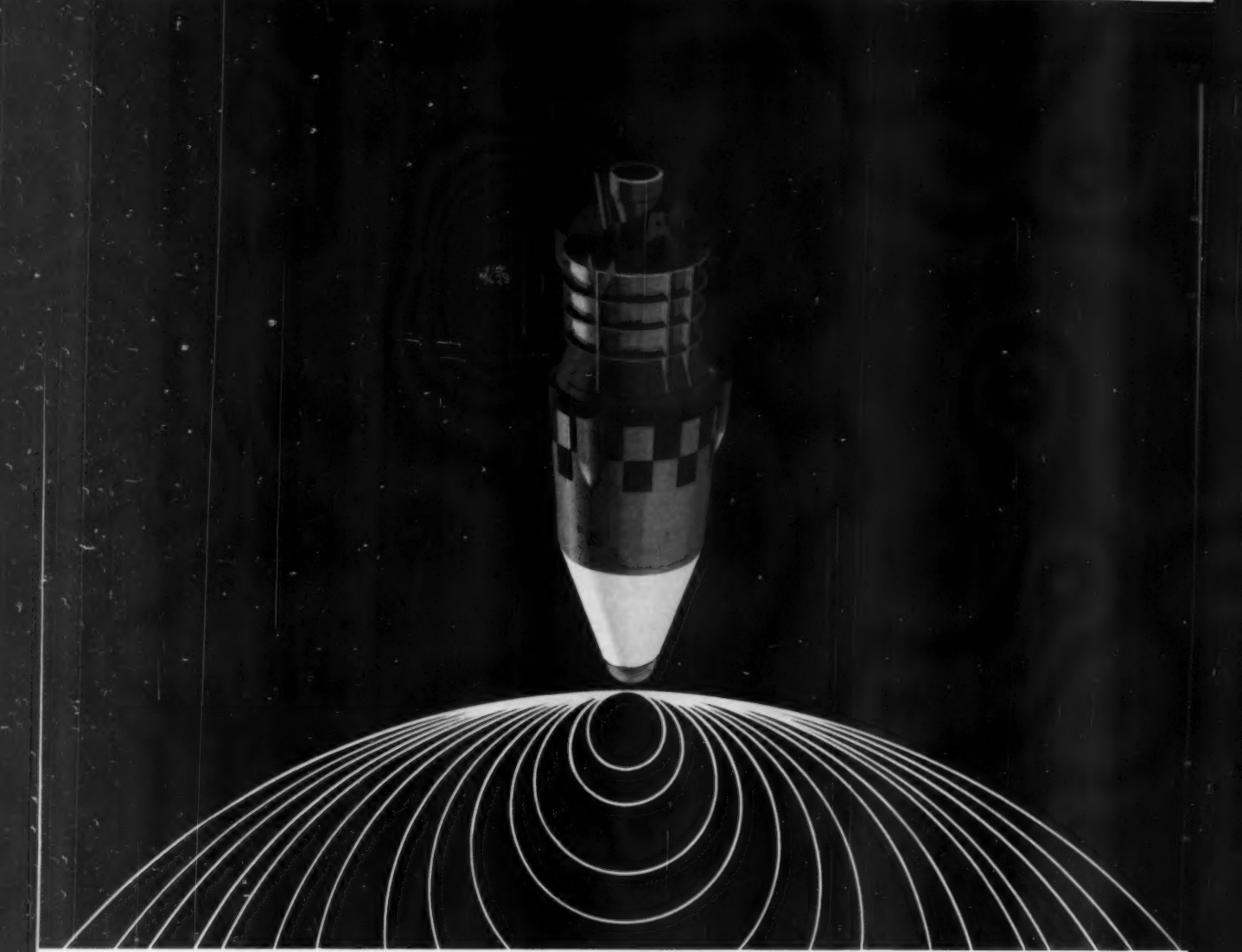

"MIDAS" REPORTS

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MIDAS II, the experimental "sentry in space," is the forerunner of a series of satellites that will detect the launching of ballistic missiles anywhere on earth and instantly relay the warning. Its entire communications system was designed and produced by Philco's Western Development Laboratories for the U.S. Air Force, as associate contractor with Lockheed.

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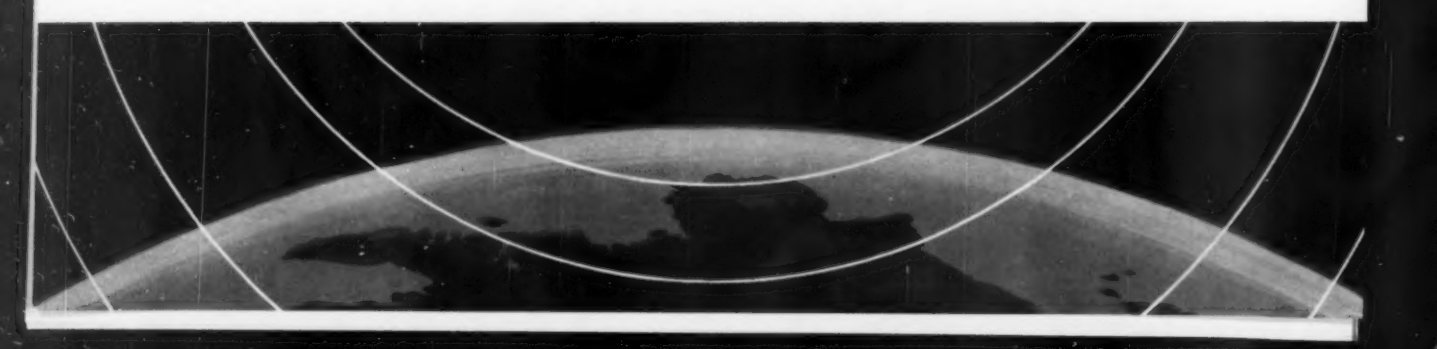

NEW DEVELOPMENTS

New Tank Ammunition

A revolutionary development has been made in Army ammunition which provides for complete combustion of the cartridge case when fired in a gun. The casing is designed primarily for use in tank guns, but testing is under way now for use in artillery weapons. The ultimate aim is for its use in all Army guns.

The new casing not only minimizes gases released from fired ammunition but leaves no residue in the gun tube after firing which could cause premature detonation of the succeeding round.

Up to ten times lighter than a conventional brass case, depending on ammunition caliber, the combustible case will lead to improved storage, shipping, and handling, and less gun-crew fatigue. It is less susceptible to handling damage such as dents and scratches, and, like conventional cases, will not explode if hit by bullets or shell fragments.

The new shell case has proved its effectiveness in a series of tests which followed five years of extensive research and engineering. The work was done cooperatively by the United States Army Ordnance Corps and private industry. The bulk of the work took place at Picatinny Arsenal, Dover, N. J.; the Armour Research Foundation, Chicago, Ill.; and the Ballistic Research Laboratories at Aberdeen Proving Ground, Md. Picatinny Arsenal is the Army Ordnance Corps' principal research and engineering center for special weapons and ammunition.

First Minuteman Wing

The 4062nd Strategic Missile Wing, the Air Force's first mobile Minuteman missile unit, was activated recently at Hill AFB near Ogden, Utah. The Wing will be part of SAC's 22nd Air Division at Malmstrom Air Force Base, Mont., and will be assigned two squadrons in 1962.

Personnel assigned to the 4062nd will participate in the development of the mobile Minuteman missile program and initiate a training schedule for those to be assigned to the operational squadrons. They also will man trains equipped with the Minuteman over the Nation's railroad network.

Weapon Systems Survey

A survey of management practices employed by the Air Force and its major contractors has been directed by the Secretary of the Air Force in the hope that improvements can be effected in the acquisition of weapon systems. A principal objective of this research program is to determine whether present management methods will continue to keep pace with the rapidly advancing technology of modern weaponry.

The Martin Company's Titan program has been selected as the initial survey project because of its importance to the national defense and because its complex nature generates problems common to most advanced weapon systems.

Combat Gas Masks

The new M17 combat gas mask is being produced for the Chemical Corps of the Army by Firestone Tire & Rubber Company, Akron, Ohio.

The M17 is the first major change in mask evolution since 1947. Developed by the Army Chemical Corps, it is designed to give respiratory protection against war gases, germ-warfare agents, and airborne radioactive fallout particles.

The new M17 combat gas mask.

A major feature of the mask is that it does not have the protruding canister common to the masks of all armies of the world since the canister has been eliminated through the use of a newly developed lightweight filter material. Pads of this material are enclosed within cavities molded into the rubber facepiece of the mask.

New Warning Systems

The Nation's Conelrad alert system was updated to the missile age recently when an agreement was signed allowing for a nationwide alert in less than ten minutes.

The agreement, signed in New York by the Air Force, the Federal Communications Commission, the Associated Press, and United Press International, will integrate the entire facilities of the two major wire services for use as an alert system in event of a national emergency.

Under the new system, virtually every radio station in the Nation can be notified in three to eight minutes after it is determined by the Air Force that an enemy attack is likely or under way.

A single man in the U. S. Air Defense Command in Colorado Springs can trigger an alert to the two wire-service news centers. Thousands of wire-service machines will immediately alert radio broadcast stations throughout the Nation to go on a Conelrad alert. The old alert system using telephonic communications took up to one hour.

In a similar development, the Office of Civil and Defense Mobilization reported the successful testing of an OCDM indoor warning buzzer called NEAR (National Emergency Alarm Repeater) and the activation of the first of three stations in the Ballistic Missile Early Warning System at Thule, Greenland. The civil-defense warning system is linked to BMEWS through continental air defense headquarters.

The small NEAR buzzers can be plugged like any electrical appliance into a regular electrical outlet in the home or any building. They would be sounded as an attack warning by an impulse sent over ordinary power lines when necessary signal generators are installed in the Nation's power systems. The device should sell for less than $10 when mass-produced.

New Grenade Launcher

A new grenade launcher, the XM79, which is capable of destroying enemy machine-gun nests, bunkers, and small troop concentrations out to a maximum range of 400 meters has been developed by the Army. (See photo on page 500.)

The new 40-mm. weapon will supplement the Army's newest rifle, the M14, and the new M60 machine gun. Combined with these weapons, it will provide increased mobility, firepower, and independence of action to the infantry platoon.

The launcher system consists of a lightweight launcher and a 9-ounce round of high-explosive ammunition. It will give the individual soldier an area fire capability between the maximum range of the

hand grenade and the minimum range of the mortar. The launcher weighs 6 pounds and is 28.6 inches long.

The 9-ounce complete round fires a 6-ounce projectile at a muzzle velocity of 250 feet a second. A delay arming fuze protects the firer from the deadly effect of the exploding projectile.

The 40-mm. launcher is an extremely simple weapon. It has a double-action mechanism of the break-open type and resembles a single-barrel shotgun in appearance. Its light weight is due in part to the use of aluminum where practicable —it is the first Army weapon to use an aluminum barrel.

Computer Speeds Skybolt

A technique of electronic forecasting is being used to speed development of the Air Force Skybolt program. The technique, called program evaluation procedure, or PEP, is essentially a digital-computer-analyzed review of every detail of the Skybolt program, an air-launched ballistic missile system under development by Douglas Aircraft Company.

Armed with this fourth-dimension eyesight, the Skybolt management team of Air Force and Douglas can project today's activities far into the future to predict possible bottlenecks and permit reassignment of men or materials to prevent delays from developing.

At the Wright Air Development Division, Wright-Patterson Air Force Base, Ohio, Air Force technicians analyze data from Douglas along with data from other Air Force commands participating in the program. From information supplied by the computer, the Air Force not only monitors the Douglas program but is able to plan phasing-in of B-52 bombers and their crews, training requirements, logistics support, and other actions necessary to bring Skybolt into operation.

Seismic Station Completed

A new seismic research station designed to study the problem of detecting and identifying both earthquakes and underground chemical and nuclear explosions has been completed at Fort Sill, Okla. The station, to be called the Wichita Mountains Seismological Observatory, is part of the U. S. seismic improvement program known as Project Vela-Uniform.

This station fulfills the original conditions of the Conference of Experts, consisting of representatives of the United States, United Kingdom, France, Canada, U.S.S.R., Romania, Czechoslovakia, and Poland who met at Geneva, Switzerland, in 1958 to "study the possibility of detecting violation of a possible agreement in the suspension of nuclear tests."

The observatory has been developed and will be operated by the Geotechnical Corporation of Garland, Tex., under the technical supervision of the Air Force Technical Applications Center. The program is under the over-all direction of the Department of Defense's Advanced Research Projects Agency.

New Compact Vehicle

A small utility car, called the Crofton Bug, is being tested and evaluated at Schilling Air Force Base, Salina, Kans., and Randolph Air Force Base, in San Antonio, Tex.

The Bug is a small, multipurpose vehicle constructed for the byways, rather than the highways. It is 105 inches long, 48 inches wide, and has a 40-inch tread and 63-inch wheel base. The frame, axle, and other structural components are actually strong enough to support a car twice the weight of the 1,100-pound Bug, according to the manufacturer, Crofton Marine Engine Company in San Diego, Calif.

The Crofton Bug being tested.

The vehicle is said to be capable of carrying a payload equal to its own weight at speeds up to 50 miles an hour while delivering more than 30 miles per gallon. The addition of an optional, 6-speed, compound transmission equips the Bug to perform towing and tugging operations in any environment.

The standard Bug has a 3-speed transmission, with synchromeshed second and high, and is powered by a 35-horsepower, overhead-cam, liquid-cooled, 4-cylinder Crofton gasoline engine.

Zeus Motor Tested

A new design of the relatively small rocket motor that will power the last stage of the Nike Zeus antimissile missile has been successfully fired in a captive test at the Redstone Arsenal plant of the Thiokol Chemical Corporation, Huntsville, Ala.

The solid propellant motor of unique spherical shape will propel the last stage of the 3-stage Nike Zeus missile. Thiokol, propulsion subcontractor, developed it to meet specifications set by the Douglas Aircraft Company, subcontractor for missile development. Western Electric Company is prime contractor for the Nike Zeus system under the supervision of the Army Rocket and Guided Missile Agency, an element of the Army Ordnance Missile Command.

The small rocket motor is designed to maneuver the missile's third stage in response to steering orders from control centers on the ground. These centers are designed to "think" for the defending Zeus missile and direct it to intercept an ICBM warhead on the fringes of space. There, detonation of the Nike Zeus' nuclear warhead will render the attacking ICBM's thermonuclear warhead harmless without damage to the defended area.

New Seaborne Radar

The first single-antenna seaborne radar providing simultaneous information in range, bearing, and height on air targets is installed or planned for installation on all Navy cruisers and guided-missile frigates and destroyers.

Called Frescan, the powerful, lightweight, all-weather radar was developed by the Navy and Hughes Aircraft Company and is now in production. The system uses a single antenna, transmitter, and receiver. It automatically transmits information to the ship's combat information center and weapons-control station.

The system has eliminated heavy mechanical stabilization equipment formerly used to keep the radar antenna platform level. The Frescan antenna is affixed to the masthead and allowed to roll and pitch with the ship. Gyromeasured roll and pitch signals are supplied to a computer which corrects for the shifts.

Better Air Communication

Radio signals bounced off the troposphere will give better communication on the air routes over the North Atlantic if the Federal Aviation Agency is successful in a development project now under way. Equipment, including a special antenna system and a high-powered amplifier, has been ordered by the Research and Development Bureau of the FAA for tests to learn whether such a "forward-scatter" method of transmitting can be made effective in the very high frequencies now used for airways communications.

The "forward-scatter" principle, in use in our northern defense lines for several years, now gives crystal-clear voice communication between places as distant as Kotzebue, Alaska, and any continental U. S. city. It involves directional broadcast of radio waves, some of which are bounced back from the troposphere earthward where they are received with exceptional clarity. Only recently it became evident that this technique could be applied to aeronautical communications where one station is moving.

If these frequencies can be used, the result would be a very flexible system in an area where good communications are now

to find a better way...

There are in the American Ordnance Association scores of Technical Sections with membership spread across the country and comprising some 4,500 members.

These Technical Sections were set up more than a decade ago at the request of Army, Navy and Air Force to advise the Services on all matters pertaining to research, development, product engineering and manufacture of all weapons and weapons systems. Meetings are held regularly, many behind closed doors.

Section members are highly qualified scientists, engineers and executives representing more than 1,000 leading American corporations. Officers of Army, Navy and Air Force are assigned by the Services to meet with the various Technical Sections.

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often interrupted. A minimum of additional equipment would be required in the aircraft now flying the routes.

Vehicle for Mauler

A vehicle and pod assembly for the Army's new Mauler, a highly mobile battlefield air-defense missile system, is being developed by Food Machinery and Chemical Corporation's Ordnance Division in San Jose, Calif.

The lightweight, tracked vehicle will incorporate standard component parts contained in the family of vehicles headed by the M113 aluminum-armored personnel carrier.

The Mauler missile will be radar-guided, employing a solid-propellant rocket motor, and will be prepacked in lightweight cases that will serve both as shipping containers and launching tubes. Hughes Aircraft Company will develop the guidance unit.

The Mauler will be a compact, mobile weapon system designed to destroy short-range, enemy ballistic missiles and rockets in the battle area and high-performance tactical aircraft that bomb, strafe, harass, or reconnoiter near forward battle area positions. Each missile unit will carry self-contained detection and fire-control equipment as well as its own battery of missiles.

New Navy Aircraft

The Navy recently accepted the W2F-1 Hawkeye airplane—a carrier-based early-warning and intercept control, twin-engine aircraft. It is designed to protect task forces from airborne attack by detecting and evaluating the full nature of the attack in advance of the minimum lead time necessary for interception and destruction of supersonic attacking aircraft. (See photo on page 510.)

Incorporated in Hawkeye is an airborne tactical data system (ATDS), consisting of autodetection radar, airborne computers, a memory, and a high-speed data-link system. This automatic system collects, stores, collates, and relays information and gives Hawkeye automatic direct command and control of interception.

The aircraft carries a crew of five, and is powered by two T-56-A8 Allison turboprop engines fitted into its high fixed wing.

Ordnance Drawings Speeded

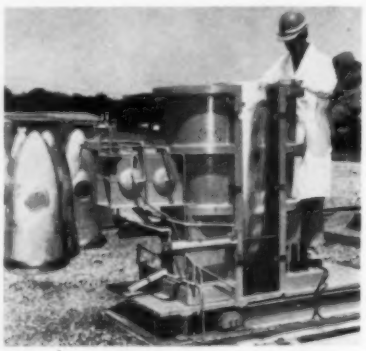
Extra copies of engineering drawings are made faster and easier, retrieval of records from files is simplified, and costly man-hours are saved at the U. S. Army's Pueblo Ordnance Depot, Pueblo, Colo., since installation of new automatic microfilm reader-printers. Charged with missile overhaul, modification, fire control, and rebuild, the depot's filing and retrieval problem in the past involved delays and heavy expense in the duplication of engineering drawings.

Solution to the printing problem came with the installation of two new reader-printers. Both units function as ordinary readers but have the additional advantage of making prints by push button in less than ten seconds. Aperture cards are merely inserted, and working prints emerge ready for distribution without delay. One unit makes 8½" x 11" copies while the other is used for larger 18" x 24" prints.

Explosive Metal Forming

Production parts of common metals are being explosively formed in high quantities by Rocketdyne, a division of North American Aviation, Inc., for Atlas and Saturn rocket engines and for Hound Dog air-to-ground missiles.

Considered to be a significant new application of a process formerly directed toward difficult, high-strength materials, the production forming of common metals can now be done at costs claimed to be competitive with other methods.



Explosive forming of aluminum pylons.

The company announced that its technical staff and explosive-forming facilities would be offered to other industries for the investigation of metalworking problems.

Parts successfully formed by Rocketdyne range in size from small tube ends with a diameter of only one-fourth of an inch to very large parts more than five feet in diameter. Metal sheets that have warped during welding or heat-treat processes also have been explosively flattened. Parts have been successfully formed from high-strength metals such as Rene 41 and titanium as well as from common metals and plastics.

High-Speed Cameras

Army scientists are using the world's fastest camera to study what happens to explosive materials during detonation. The camera, located at the Army Ordnance Corps' Picatinny Arsenal, Dover, N. J., has an exposure speed of one five-billionth of a second. For comparison, one five-billionth of a century is half a second.

Intense light required by the camera is provided by setting off an argon gas bomb simultaneously with the explosion being photographed. In experiments so far, the device, called a Kerr camera, has made still photographs of explosion shock waves traveling as fast as 5 miles a second (18,000 miles an hour).

A camera capable of taking 100 million frames a second also is being used in explosives research at Aberdeen Proving Ground, Md.

Designed by Morton Sultanoff of the Army Ordnance Corps' Ballistic Research Laboratories at Aberdeen as an aid in ballistics research, the camera, which literally was made from scrap equipment and "odds and ends" in the laboratory, cost less than $500. Photographs have been taken with it to show the actual explosion of a shell, the penetration of armor plate by a shaped charge, and the complete history of an explosion from detonation to shock, even though the period of the latter is only millionths of a second.

Missile Master Completed

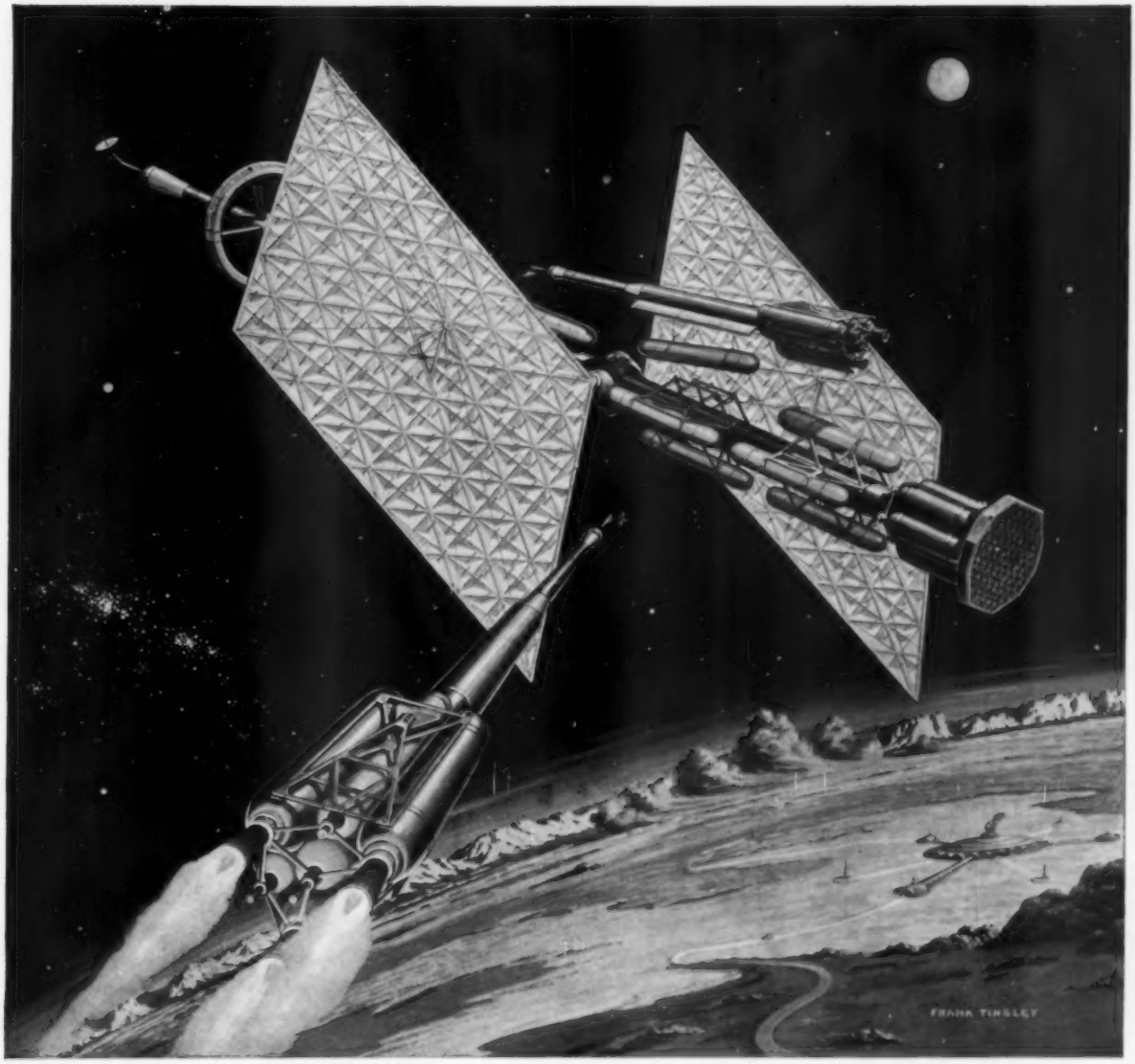
The Army in December successfully completed a network of electronic centers designed to coordinate air defenses of key industrial and population centers in this country. Called Missile Master, the centers are located in the Washington-Baltimore, Seattle, Boston, New York, Buffalo, Detroit, Pittsburgh, Philadelphia, Chicago, and Los Angeles areas.

Missile Master is basically a communications and fire-coordination system linking all Nike missile batteries defending a given geographic area. By tying in to the Air Force Sage (semiautomatic ground environment) centers, Missile Master also links the Nike defenses to the over-all North American Air Defense Command network.

High-Speed Facsimile

A high-speed facsimile system developed by the Hogan Faximile Corporation and sponsored by the Navy's Bureau of Ships will transmit microfilmed engineering drawings or printed pages from one point to another and reproduce them enlarged on translucent paper at the receiving end at the rate of twenty-six feet a minute. The new system is expected to overcome a serious distribution problem pertaining to construction diagrams and plans for Navy ships. Blueprints for a single ship such as an aircraft carrier weigh as much as 300 tons.

The new system consists of a scanner which picks up images from microfilm and a recorder which receives the images from the scanner either by coaxial cable or microwave (radio) transmission network.



STEPS IN THE RACE TO OUTER SPACE

Mars Supply Fleet

When man first sets up colonies on Mars, his life will depend on a Mars Supply Fleet, shuttling from Earth at regular intervals with supplies, equipment and personnel.

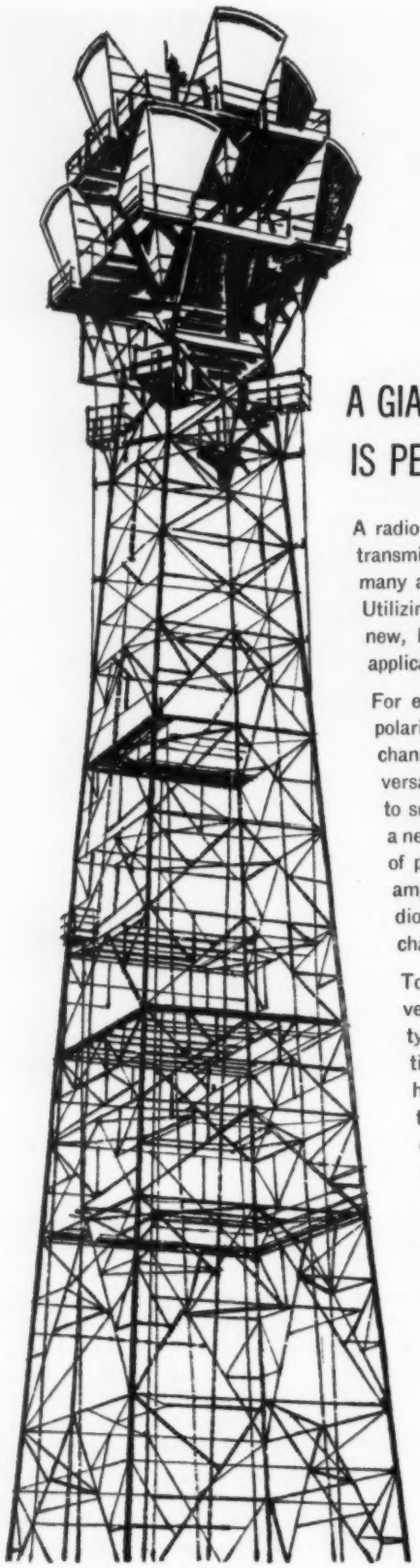
The fleet will be comprised of two basic vehicle types, both shown in the illustration above. The large ships with rectangular solar reflectors will be the long-range backbone of the fleet. Assembled in orbit of prefabricated sections rocketed up from Earth, these high-capacity carriers will have a low-thrust electro-particle drive. Their operating current will come from thermionic converters, heated by the concentrated rays of the reflectors.

The Solar Ships will be loaded and unloaded, at both ends of the voyage, by work-horse Ferry Rockets (foreground) launched by booster. The ferries will be designed to carry the long yellow cargo containers within a bay just forward of their engines. In the nose of the Ferry Rocket is the passenger and operating section with a universally mounted spherical guidance compartment. This guidance unit will be fitted with directional radar, an optical telescope, and full astrogational equipment.

The Mars Supply Fleet will complete each assigned mission in one to two Earth years, depending on whether or not the Solar Ships are equipped with auxiliary boosters for extra initial speed.

ARMA, now providing all-inertial guidance systems for later models of the Air Force ATLAS ICBM, is in the vanguard of the race to outer space. At ***ARMA***, privately funded research programs in space technology are studying super-sensitive inertial devices for navigation and satellite instrumentation. For this effort, ***ARMA*** seeks scientists and engineers experienced in astronautics. ***ARMA***, Garden City, New York. A Division of American Bosch Arma Corporation.

AMERICAN BOSCH ARMA CORPORATION



A GIANT RADIO HIGHWAY IS PERFECTED FOR TELEPHONY

A radio relay system operating at 6 billion cycles per second and able to transmit 11,000 voices on a single beam of microwaves—several times as many as any previous system—has been developed at Bell Laboratories. Utilizing the assigned frequency band with unprecedented efficiency, this new, heavy-traffic system was made possible by the development and application of new technology by Bell Laboratories engineers and scientists.

For example, they arranged for the waves in adjacent channels to be polarized 90 degrees apart, thus cutting down interference between channels and permitting the transmission of many more telephone conversations in the same frequency space. They developed ferrite isolators to suppress interfering wave reflections in the waveguide circuits; and a new traveling wave tube that has ten times the power handling capacity of previous amplifiers and provides uniform and almost distortionless amplification of FM signals. They devised and applied a new high-speed diode switching system which instantly switches service to a protection channel when trouble threatens.

To transmit and receive the waves, the engineers applied their invention, the horn-reflector antenna. Elsewhere, this versatile antenna type is brilliantly aiding space communication research in the reception of radio signals from satellites. For radio relay, a single horn-reflector antenna can efficiently handle both polarizations of the 6000 megacycle waves of the new system; at the same time it can handle 4000 and 11,000 megacycle waves used for existing radio relay systems. Thus it enables all three systems to share economically the same radio towers and routes.

Produced by the Bell System's manufacturing unit, Western Electric, the new system is now in operation between Denver and Salt Lake City, and will gradually be extended from coast to coast. This new advance in radio technology is another example of how Bell Telephone Laboratories works to improve your Bell communication services.

BELL TELEPHONE LABORATORIES

World center of communications research and development

MATERIALS PROGRESS

George S. Brady

Railroads and Defense.—During the two World Wars the railways constituted a vital part of our logistical effort, and there are strong reasons why they are still of great importance in spite of the big advances in highway hauling. It seems reasonable to assume, therefore, that a healthy operating position for the railroads should be a major consideration in our present "defense effort."

It is not the intention here to discuss the many economic and possibly political factors that may have a bearing on the present insecure operating position of the railways. But in times of emergency the military authorities have had to see that priority treatment was accorded to the supply of great quantities of scarce materials to the railways, and their physical condition is thus a legitimate interest in military logistics.

The recent vast highway-improvement program projected by Federal and State governments has caused many to believe that railways are obsolete, but anyone who is familiar with the complex subject of freight haulage knows that this is far from the truth. Unquestionably, there are advantages in truck haul for some types of cargo, especially in portal-to-portal short haul of small-volume general cargo.

There thus appears to be some substance to the complaints of the railroads that with Federal and State aid the trucking industry has been able to take the most profitable "cream" of the freight business. However, we will confine the discussion here to matériel, which is truly a basic consideration in logistics.

Highway truckers have been giving increasing attention to lighter-weight equipment to increase payload capacity and cut down operating costs, and to corrosion-resistant materials to decrease maintenance expenses. Recent surveys by the Trucking Association indicate that an annual saving of $1.00 to $1.50 is made for every pound cut from the gross weight of a truck. In other words, a reduction of 1,000 pounds in the weight of a truck, with proper design attention to materials that will reduce maintenance, can save the operator a minimum of $1,000 per year per unit. Since railway units are far larger than truck units, the theoretical savings should be much greater.

Aluminum industry engineers do not consider that a major break-through has yet been made in the use of the light metals for railway transport equipment, since most of the aluminum cars bought have been for home use. The railroads have pointed out that cars are off the home system most of the time (eighty per cent in the case of boxcars), and the owner thus does not reap the benefit of hauling savings. However, it seems obvious that if all roads used lightweight cars this argument would not apply.

The American railroads have two million freight cars. Last year 89,000 were retired, but only 41,400 were bought. It is stated that more than $500 million was spent last year on freight car repairs (not including routine maintenance), making an average of about $250 per car. Engineers maintain that, although considerable of the repairs are due to damage, as much as thirty per cent of total maintenance costs can be cut off by the use of lightweight, corrosion-resistant materials. Other advantages given for newer designs of cars are greater payload capacity with fewer cars to handle and lower operating costs.

The 1,205 aluminum freight cars recently acquired by the Southern Railway consisted of 750 gondola coal cars and 455 covered hopper cars, all for use on "home service." The smallest of the covered hopper cars, built by the *Major Car Corporation*, Clifton, N. J., have a capacity of 4,713 cubic feet and are constructed of aluminum alloy 5083-H113 plate, with extrusions of alloy 5083-H112, and castings of alloy 356. The car is stated to be five tons lighter than a car of similar capacity made with low-alloy, high-tensile steel, and it requires no painting.

Recent purchases of light-metal cars by the Canadian National Railways also indicate an adherence to the principle of buying the more-expensive modern designs of cars for "home service" only. In this respect "more expensive" should be considered as a relative term because, unless the modernization is extended to include roller bearings and other design features to make possible further savings in torque, fuel economy, and maintenance, the use of light metals in bodies does not always increase the cost greatly.

All-aluminum hopper cars being built by *Marine Industries, Ltd.*, Sorel, Quebec, for the CNR, will increase the payload capacity by ten tons. With a light weight of 17 tons, the car has a capacity of 88 tons, or 3,000 cubic feet. In using aluminum, the designers broke away from conventional form and adopted a curved shape with the plate welded flat and then bent in place around the circular ends, eliminating the usual side posts. The design reduces construction costs and increases volume capacity. The aluminum plate, without painting, withstands better than steel the sulphur corrosion of coal and ores.

Beryllium Progress.—The $300,000 research and development contract given by the Air Matériel Command to the *Beryllium Corporation*, Reading, Pa., for experimentation on beryllium rolling methods is indicative of the Air Force's interest in this "rare" metal as a construction material. Lighter in weight than aluminum, it has a strength-weight ratio comparable to high-strength steels. It forms an oxide protective surface and resists further oxidation at temperatures to above 1,400 degrees Fahrenheit. Its high thermal conductivity, nonmagnetic qualities, and low neutron absorption also are desirable features for advanced aircraft.

Beryllium Corporation already has broken away from the powder-metallurgy method of handling beryllium and has made fine-grained sheets from vacuum-melted billets by electrobeam melting, extruding, and then rolling. The crude metal is still expensive, but new sources and new reduction methods are expected to decrease costs and increase supplies. It is estimated that a thirty per cent increase in supply will be required within five years.

Up to very recently the only usable ore has been beryl, a complex silicate, $Be_3Al_2Si_6O_{18}$, resistant to acids and from which it was expensive to extract the metal. The metal actually occurs in more than thirty minerals, some of which are quite abundant. One of the new sources, the vitroite of Utah, is a mineral of simpler composition distributed in the rock and capable of being acid-leached. (*Contd. on p. 552*)

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

Materials Progress (Contd.)

New Reactor Fuels.—*Battelle Memorial Institute,* Columbus, Ohio, has been experimenting on uranium-oxide beads encased in a ceramic coating to make a reactor fuel that does not emit dangerous fission products. Uranium-oxide particles about 0.066-inch in diameter are coated with about 0.001-inch of aluminum oxide.

This coating is impervious even to the radioactive isotopes of such gases as xenon, and only the useful power-providing rays can escape. These are not dangerous at a distance of five or six inches from the source, so that the requirements for shielding are reduced. It also reduces corrosion problems and eliminates melt-migration of the uranium fuel.

The aluminum oxide coating can be used at reactor temperatures to 2,300 degrees Fahrenheit. For higher temperatures, coatings of pyrolitic graphite or beryllium oxide are suggested, or the alumina-coated beads can be encased in small graphite spheres. The new bead fuel will be commercialized by the *Minnesota Mining & Manuacturing Corporation.*

At the same time, the Oak Ridge plant of the Atomic Energy Commission has been experimenting with a molten reactor fuel that is safer than conventional uranium-oxide fuel, permits higher temperatures, and is easier to reprocess. The new fuel is uranium fluoride dissolved in a mixture of lithium and beryllium fluorides.

Plastic Boats.—New, fast, 16-foot boats developed by the Coast Guard at Curtis Bay, Md., will carry six passengers and support a dead-weight load of 700 pounds. The hulls are molded of epoxy resin with glass fabric reenforcement. The safety flotation chambers are completely filled with rigid urethane foam of 1.75 pounds per cubic foot density, blown into place with Freon fluorinated hydrocarbon which produces a tiny closed-cell structure in the foam.

Submicro Particle Grinders.—The advantages of fine particle size for pigments, fillers, colloidal suspensions, and for inorganic reenforcing agents in coatings, adhesives, and plastics, has been known for a long time. But it has been difficult and costly to grind minerals to submicro particle size with conventional equipment. Now, *Southwestern Engineering Company,* Los Angeles, Calif., has a mill that will grind tough, hard materials to particle sizes as small as one micron. Called a "vibro-energy mill," it operates through high-frequency, 3-dimensional vibration.

High-Temperature Transistors.—*Westinghouse Electric Corporation* is now in production on transistors of silicon carbide capable of operation at temperatures above 650 degrees Fahrenheit. The crystals have less than one part impurity in 10 million parts of silicon carbide. The material is unipolar and does not require a third voltage to accelerate electrons. Transistor crystals for space rockets are very small—only 0.080-inch in diameter.

Aluminum in Ships.—The first nuclear-powered aircraft carrier, the 86,000-ton U.S.S. ENTERPRISE, which has been called a "mobile air base," has its 252-foot-wide flight deck made of aluminum plate and extrusions. The 4-jet-plane elevators, each 85 feet long and 52 feet wide, are of welded aluminum alloy 5456. Each weighs 105 tons, 30 tons less than if built of high-tensile steel. The ship was built by the *Newport News Shipbuilding & Drydock Company,* Newport News, Va.

Another new design in marine construction is a 75-foot-long, 18-foot-beam yacht built by the *Burger Boat Company,* Manitowac, Wis. It has an all-aluminum hull and superstructure, using 20 tons of aluminum alloy 5154 plate and sheet, and alloy 6061 extrusions. The yacht is stated to be 20 per cent lighter than a steel boat, with an improvement of 10 per cent in speed. The two 336-horsepower diesel engines give a 1,600-mile cruising range without refueling.

A New Starch Plant.—*Morningstar-Paisley, Inc.,* is building a new 7,500-ton-a-year potato starch plant in Maine to produce etherized and other modified starches. There are actually about 1,000 different starches on the market, most of which are made from the less costly corn. Starch has innumerable uses, for textile and paper coatings, for copolymer plastics, adhesives, gelling agents, and as non-crystallizing saccharides in foods.

Among the military uses are in signal lights and in nitrostarch explosive. Potato starch, with is ellipsoidal lamellar structure instead of the polygonal structure of cornstarch, is claimed to have greater clarity, more stability, and greater resistance to flexing in coatings.

Vanadium Source.—A new source of vanadium metal is the vanadium-bearing slag from the Idaho phosphorus workings containing up to five per cent vanadium. It will be concentrated to about thirteen per cent, and a new plant of the *Minerals Engineering Company* at Salt Lake City, Utah, will treat the concentrate by a chemical-metallurgical process to yield vanadium pentoxide.

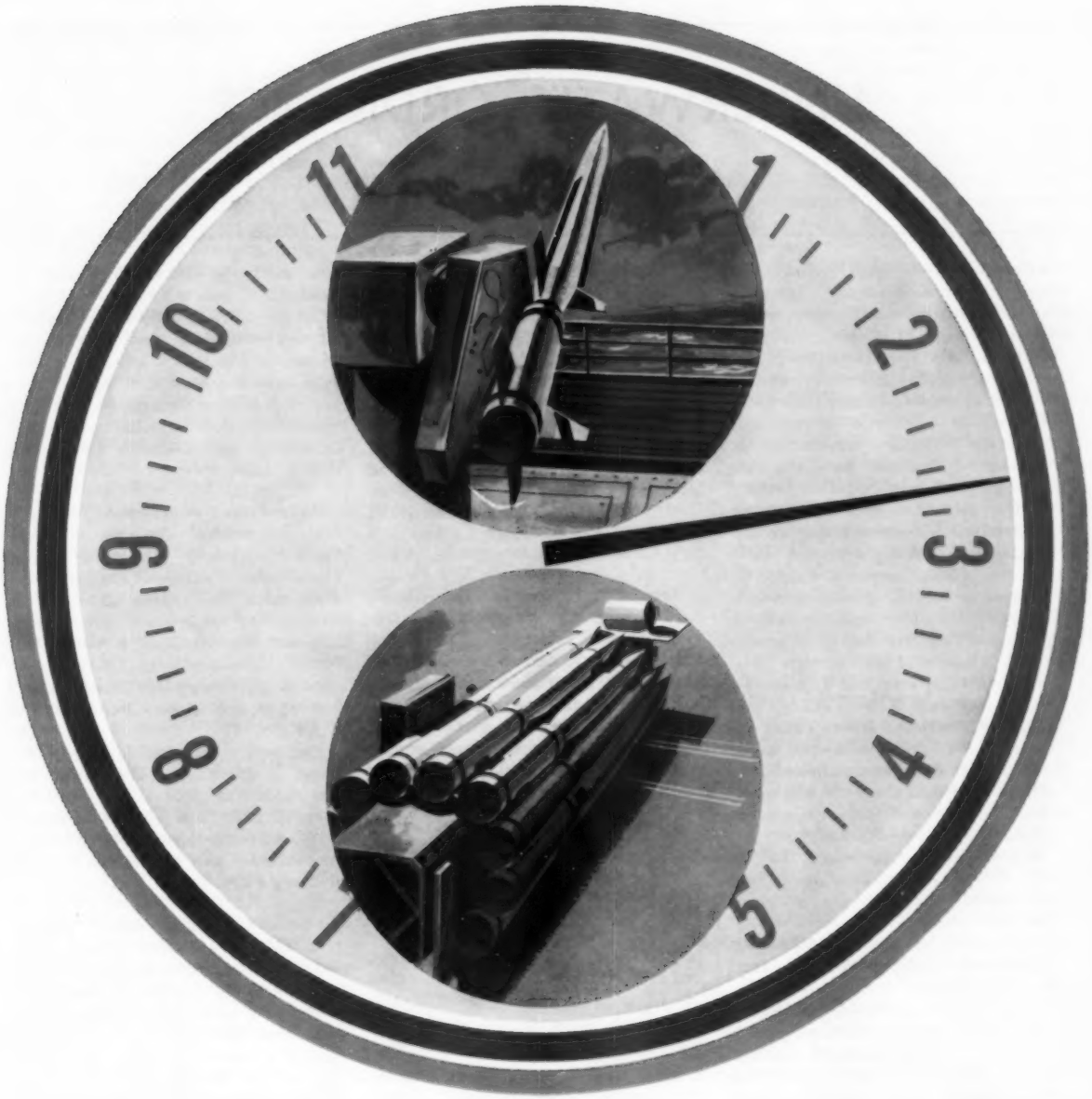
Ceramic Tank Lining.—The *Pfaudler Company,* Rochester, N. Y., has a new highly resistant ceramic lining for metal tanks, called Nucerite. It is an opaque crystallized "nucleated" glass with impact strength eighteen times that of plate glass. The abrasion resistance is four times that of hard glass, and the heat transfer is stated to be thirteen times better than conventional "porcelain." It will withstand temperature differences of 1,200 degrees Fahrenheit, compared with 350 for porcelain, and it can be used for operating temperatures to 2,000 degrees Fahrenheit.

New Thermoelectric Compound.—A thermoelectric material with a high energy-conversion efficiency for converting heat to electricity is a silver-antimony-telluride, $AgSbTe_2$, developed by *Bell Telephone Laboratories, Inc.,* Whippany, N. J. It has a very low thermal conductivity, about one-hundredth that of germanium, making it easier to maintain a temperature gradient between the two ends of the thermocouple. The compound has an irregular cubic structure and is thermoelectrically positive.

Nickel-Aluminum Coating.—The *National Bureau of Standards* has developed a process for protecting steel or molybdenum with a nickel-aluminum coating that will withstand temperatures to 1,800 degrees Fahrenheit without oxidation. Nickel is first electrodeposited on the steel from a chloride-sulphate bath. Aluminum is then electroplated from a hot solution (1,300 degrees) of potassium chloride, sodium chloride, and cryolite. Rather than being deposited, the aluminum is diffused into the nickel, producing an alloy. Nickel-aluminum alloy is normally very brittle, but when produced as a coating by electroplating, it is ductile.

New Packing Material.—A new highly chemical resistant and flexible low-friction packing material for valves, pumps, and other uses is Flexrock 405 of the *Flexrock Corporation,* Philadelphia, Pa. It consists of fine Teflon fibers braided over a braided glass-fiber core and the ropelike assembly impregnated with Teflon. Also, for gaskets and diaphragms to be used for operating temperatures higher than those possible with ordinary resin-impregnated materials, *Reeves Brothers, Inc.,* New York, N. Y., has a new woven sheeting called Reevecote. It is a Dacron fabric impregnated with Kel-F fluorocarbon plastic.

High-Strength Aluminum.—The 35.5-inch-diameter, 72-inch-long tank of the new Bomarc-B missile is made of high-strength aluminum alloy 2219, with the alloy sheet welded to 7 roll-forged rings of the same alloy. The 80-foot assembly of the booster unit of the Saturn space rocket is also of aluminum, with about 11 tons of alloy 5456 sheet. But the double-walled, liquid-cooled panels proposed by *Bell Aircraft Corporation,* Buffalo, N. Y., for hypersonic aircraft will use Haynes alloy 25 for the outer skin to withstand the high heat of flight. This alloy contains about 50 per cent cobalt.



FROM REST TO READY....**LESS THAN A MINUTE**

■ Below deck, missiles are stored naked, stripped of stubby wings. But in less than 60 seconds they're assembled, loaded and fired, thanks to automation. ■ Take this concept – develop the idea into today's mighty missile systems. Vitro did: its technical staff helped the Bureau of Naval Weapons design fully-automated missile handling and launching systems – ones now used aboard frigates, cruisers and carriers armed with fast, ship-launched Terrier and Talos missiles. ■ Vitro scientists and engineers went right to work during basic ship design – providing space needed for automatic storage and handling. Beyond this, Vitro takes ideas and develops actual systems for feasibility testing.

Vitro

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SCIENTISTS AND ENGINEERS: JOIN THIS TEAM

UNDERWATER ORDNANCE

Seabrook Hull

Polaris on Patrol.—Last November, the FBM (fleet ballistic missile) submarine GEORGE WASHINGTON put to sea with a full complement of sixteen 1,200-mile Polaris ballistic missiles—a completely operational weapons system and one of the great accomplishments of underwater ordnance.

Since the first Navy statement of its long-range objective to develop a submarine-launched, solid-propellant ballistic missile in November 1955, this program has proceeded with greater dispatch and less fuss than probably any other major U.S. missile-based weapons system.

And on the basis of dollars spent compared with retaliatory capability in hand, it has certainly nicked the American taxpayer less than most other systems.

Through fiscal year 1961 (the current year) a total—and Admiral Raborn says this is the *complete* total—of money appropriated for the Polaris weapon system is $4.2 billion, distributed as follows:

Research, development, test, and evaluation of missiles and submarine weapons systems components—$1,475,000,000.

Shipbuilding and conversion, 14 SSBN's, 2 tenders, 4 auxiliary vessels, and long-lead-time items for subs to start in 1962—$1,942,000,000.

Procurement of missiles—$617,000,000.

Construction and communications facilities—$108,000,000.

Miscellaneous support—$58,000,000.

The Polaris missile system turns out to be an active, continuing project. The total program contemplates forty-five fully outfitted, deployed SSBN's (ballistic missile submarines—nuclear). Including procurement of 1,005 Polaris missiles, the total cost of this program is officially estimated at $8.645 billion—which puts it presently at just under the halfway mark.

Once the 45-boat, 720 (deployed)-missile capability has been achieved, current estimates are that it will cost about $1 billion a year to maintain, including: replacement of missiles at 5-year intervals, research and development for longer-range missiles, replacement of SSBN's after fifteen years or more, and normal operating expenses and system support.

Mr. Hull is an experienced author and editor in the field of modern weapons including space and air power as well as undersea warfare.

Influence of Computerized Program.—The marked success of the Polaris program will have its impact on weapons system contracting throughout the Defense Department. The computerized program control system—called PERT, for Program Evaluation Research Task—is already being employed in other Navy missile projects (such as the Typhon series), and, under a different name (PEP) is being used by the Air Force for Skybolt, B-70, Dyna-Soar, mobile Minuteman, and Titan II. The Army is applying it to Nike Zeus.

New Phase for Polaris Contracting.—As this program moves more heavily into the production area (as against RDT &E), look for a marked increase in the number and dollar volume of performance, or incentive-type contracts. These were not considered to be really practical during the development phase of the program but now they probably will be pushed.

Polaris Contractors.—Credit for the Polaris program's success goes to Navy's Special Projects Office (numbering fewer than 300 people) which is responsible for development and procurement not only of the Polaris missile but also of the submarines, tenders, all support equipment, and crew training; and to the more than 250 prime contractors and over 9,000 subcontractors (down to the second tier) that have participated in the program.

RUM Show.—Navy's Marine Physical Laboratory (Scripps Institute of Oceanography, La Jolla, Calif.) has developed RUM (remote underwater manipulator), a device with the body of a Marine Corps Ontos vehicle, an electromechanical arm, and a 3-dimensional, closed-circuit TV viewing system. At depths of 20,000 feet this monster can crawl along the ocean floor at about 3 miles an hour, negotiate 60 per cent grades, climb over vertical objects up to 12 inches high, and be remotely controlled by one man on the ocean's surface.

Object is to enable detailed examination of the ocean floor for long periods of time, collection of samples, and assembly and installation of deep-sea instrumentation.

Future developments of RUM envision attachment of a system of helicoptor rotor blades which will enable it to raise and lower itself, "fly" sideways, forward and backward, or just hover.

Control of RUM is through a specially designed silver-plated electrical cable developed by the Worcester, Mass., Electrical Cable Works of U. S. Steel's American Steel & Wire Division. RUM will be operated by both the Marine Physical Laboratory and Columbia University's Hudson Laboratories.

Underwater Photography.—Recent Fifth International Congress on High-Speed Photography (Society of Motion Picture and Television Engineers) in Washington, D.C., gave its share of attention to underwater photography. Edgerton, Germeshausen & Grier, Inc., Boston, Mass., showed oceanographic cameras, light sources, and sonar pingers that are capable of operating to depths of 37,500 feet.

Photosonics, Inc., Burbank, Calif., displayed a 16-mm. thin-line, underwater high-speed camera. D. B. Milliken Company, Arcadia, Calif., showed waterproof Milliken 16-mm. high-speed motion picture cameras with speeds from 4 to 400 frames a second.

Silence Is Plastic.—Navy's Philadelphia Shipyard is now molding epoxy resin propeller profile models. This may be a first step toward development of glass-plastic propellers for actual operational use. Such propellers are touted as having a number of major advantages; for example, their density would only be slightly in excess of that of water.

Spare blades could be carried under a submarine's superstructure decking and could be replaced at sea by appropriately equipped frogmen. Traditional practice, when a sub loses a propeller blade—as from impact with ice—has been to use primacord to blow the whole hub off.

However, the biggest gain that might be expected from plastic-glass propeller blades for surface vessels, submarines, and torpedoes is in sound transmission. Main propulsion shafts are notorious transmitters of mechanically generated sound, with the propellers acting as excellent radiators. A couple of years back, sound tracking equipment at the Naval Ordnance Test Station at China Lake completely lost sound contact with a torpedo that had been experimentally equipped with glass-phenolic blades.

Underwater Ordnance

Shock Waves in Gear Trains.—The Naval Ordnance Test Station, China Lake, Calif., has a report available to industry which suggests that gear trains may be causing noise through the generation of supersonic airflow. Theory is that gear teeth, even at relatively slow speeds, pump out high velocity air as they fold into one another, which results in increased acoustic radiated energy. For details you can order NAVORD Report 6569, OTS, U.S. Commerce Department, Washington 25, D.C.—51 pages, $1.50.

Oceanographic Data Center.—Naval Weapons Plant, Washington, D.C., has set up an Oceanographic Data Center for the collection, study, and dissemination of information in the field. Information is available to those both in and out of government.

Hydroskimmer Searcher.—Navy has received for test and evaluation Bell Aerosystems Company's ground-effect vehicle, which it calls a hydroskimmer. Navy is considering such craft as possible coastal ASW search and kill vehicles. Hydroskimmer has a fiberglass-polyester hull and uses an outboard motor as a prime mover while a fan supplies the air cushion.

Underwater Light Analyzer.—The Naval Ordnance Test Station has developed an underwater photographic spectrometer for the direct measurement and spectral analysis of light at various ocean depths. It uses a wedge interference filter. The device was developed as part of a program for expanding capabilities of underwater photography. For details, write to OTS, U.S. Department of Commerce, Washington 25, D.C. Order NAVORD Report 7040, fifty cents.

Oceanographic Business.—The Navy Hydrographic Office, Washington 25, D.C., is seeking companies with a wide range of automatic remote oceanographic instrumentation and data-recording and transmission capabilities. This is probably not a big market now, but this is the decade of growth of underwater exploration and exploitation, and experience now can provide the basis for a good volume within a few years. Write address above for details.

New ASW Helicopter.—Navy's new twin-turbine HSS-2 ASW helicopter is in the final phases of its acceptance trials, and is expected to go into operational service sometime in 1961. The HSS-2 is the Navy's first all-weather helicopter and the first that can both seek out and destroy enemy submarines while achieving maximum range.

This model helicopter has so far completed over 1,100 hours of flight test, including over 1,000 separate flights. Virtually all components have exceeded the 1,000-hour design guarantee or have achieved unlimited life. Maker is Sikorsky Aircraft Division, United Aircraft Corporation, Stratford, Conn.

A-2 Polaris Goes 1,400 Miles.—The initial second-generation Polaris test vehicle, using a second-stage monofilament-wound fiberglass motor case and high-energy propellants (aluminum powder added), when fired last fall ticked off a cool 1,400 miles down the Atlantic Missile Range. A-2 looks like A-1 (the 1,200-mile version) but is a little longer.

From Davy Jones' Locker

Problem in Search and Report: In October the British Admiralty reported that the United States is contemplating a 2,500-mile network of remotely operating sonarbuoys stretching across the North Atlantic. The same month, James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development, reported that Project Artemis "is an exploratory development effort to determine the feasibility of using very high powered sonar transducers and high-gain receivers together with advanced data-processing equipment for the detection and tracking of submarines at very long range.

Wakelin's statement and the British report probably refer to one and the same thing. In any case, an effective ocean-wide submarine detection and tracking system such as this is going to require some very sophisticated equipment with a high degree of reliability.

Problem in High-Speed Search: The advent of Russia's capability in nuclear-powered submarines that fire long-range ballistic missiles adds new urgency to the Nation's high-speed ASW search capabilities. Rear Adm. Lawson T. Ramage, director of Navy's Antisubmarine-Submarine Warfare Division, speaking at the dedication of Loral Electronics Corporation's new Bronx, N. Y., facility, stated that the need to spot and track such submarines all over the world placed increased emphasis on the airplane as an ASW search craft:

"We must take the offensive against the seaborne threat of nuclear-missile-launching submarines. This means one thing—the coverage of the vast ocean areas in the most rapid manner possible in order to seek out the enemy.

"To a naval officer this has only one connotation—naval airplanes. Therefore, I see the role of the airplane becoming even more important than it was in World War II. However, in order to fully exploit the mobility of this vehicle, we must have airborne detection systems of an even greater capability."

Almost inevitably this means a major break-through in underwater detection techniques—one, probably, that is dependent on neither sonar nor magnetic interference.

Problem in DASH: Navy's destroyer antisubmarine helicopter, the DD-based hunter-killer helicopter drone, is running into problems. These relate to guidance and control within (a) the space limitations and (b) the tossing, pitching environment of a destroyer at sea. Details are classified, but if anybody has any good ideas along this line, the Navy would like to hear of them.

Problem in Contamination: The limiting factor in the length of patrols of nuclear submarines is the endurance of the crew. Many factors affect this. One is the accumulation of contaminants—aerosols, dust, chemicals, etc.—in the submarine's atmosphere.

Fairly extensive research and development programs are under way in this area. However, since the crew is the limiting factor in the submarine's underwater endurance, here again the Navy is open to suggestions for extending human endurance in a closed-cycle environment.

UWO News Items

The Navy has cleared some details on Lulu, its latest nuclear depth bomb. Lulu can be air dropped from either land or carrier-based aircraft and will replace Betty. Naval Ordnance Laboratory, White Oak, Md., working in cooperation with the Mechanical Division of General Mills, Inc., developed Lulu.

Avien, Inc., has acquired Electrol, Inc., Kingston, N. Y. Avien manufactures instruments, controls, and other electronic items for aerospace, undersea, and industrial use.

Autonetics Division of North American Aviation, Inc., is building a new research center at Anaheim, Calif., to strengthen its hand in undersea technology, among other areas.

Aerojet-General Corporation, Azusa, Calif., has appointed Dr. R. H. McFee as director of research. He will manage the Advanced Research and Products Division and will be concerned with electronics, power, systems, and vehicles for sea and outer space.

Navy's 23-foot hydrofoil boat, boasting supercavitating hydrofoils and a gas-turbine power plant, was shown at last fall's International Symposium on Hydrodynamics at The Hague, Netherlands. This 80-mile-an-hour boat was built by Dynamic Developments, Inc.

National Academy of Sciences' Committee on Oceanography has appointed working groups in five basic technological areas as part of its international expedition which will conduct an exhaustive study of the Indian Ocean.

MISSILES AND SUPPORT EQUIPMENT

Alfred J. Zaehringer

Improved Polaris.—With the Polaris fleet ballistic missile already coming off the production lines, improvements are being sought. The present A-1 model has a range of 1,200 nautical miles. The improved A-2 will have a range of 1,500 nautical miles and development already has been started. Main difference will be a longer first stage and a shorter second stage using a glass-plastic case and double-base propellant. Improved propellants will be used in the first stage. As a matter of fact, the second stage for the new model will be nearly the same as the third stage of Minuteman.

There is now talk of an A-3 version with a range of 3,400 nautical miles. Though solid propellants are in favor, the new storable liquid combinations are expected to make a strong bid with special view to keeping the same dimensions. The Polaris test program is about over, and some fifty missiles have been tested, including a dozen missiles from the submerged submarines GEORGE WASHINGTON and PATRICK HENRY.

Big Boosters.—Existing solid rockets such as the Minuteman are being studied by NASA as possible launchers for space probes. However, for bigger and better things to come, NASA has awarded three contracts with industry for research and development on very large solid booster rockets. One system would have a launch weight of one million pounds and the two others would have weights of up to seven million pounds on launch. Each vehicle would be able to generate thrusts of two to three times the launch weight. Thus, a cluster of seven large engines would produce about twenty-one million pounds of thrust. Each engine would be about 100 feet long and have a diameter of 120 inches.

Minuteman Sites.—Sites for the first Minuteman ICBM squadron will be located near Malmstrom AFB, Mont. Award of initial construction contracts is scheduled for January 1961. Construction cost for a squadron will be about $20 million and building will take some fifteen to eighteen months. Minuteman has a range of 5,500 nautical miles and is smaller than the Atlas or Titan. The missile will be deployed by the Strategic Air Command from dispersed, hardened, underground silos and from mobile railroad cars in trains moving constantly about the Nation.

Falcon.—Over 30,000 Falcon air-to-air missiles have been delivered to the Air Force. The 30,000th Falcon, a GAR-11 model with nuclear capability, was turned out some six years after the first GAR-1 came off the assembly lines. Some 4,000 GAR-1's were built. About 12,000 GAR-1D's have been built since 1956. GAR-2 was the first infrared missile, and an improved GAR-2A went through 9,500 production units. Some 300 GAR-3 Super Falcons were made. A new motor was used for the GAR-3A and some 800 missiles were turned out.

Hawk.—New contracts totaling $10.5 million will go to provide these surface-to-air guided missiles for NATO use. The low-altitude-defense weapon recently showed that it has antimissile capabilities by hitting Honest John and Little John missiles in flight.

Nuclear Rocket.—Project Rover is expected to be accelerated under a joint NASA-AEC program. Industry is expected to come into development of the nuclear rocket engine, also. The present nuclear rocket uses hydrogen as a working fluid, and a reactor based on uranium fission supplies heat. Thrust levels at the Nevada test site are believed to be around 40,000 to 52,000 pounds of thrust.

The first-generation Rover may have around 80,000 pounds of thrust, and there are hints that a second-generation thrust capability of 500,000 to 750,000 pounds is planned. The present engine will complete ground tests in 1963 and possibly be ready for use as an upper-stage rocket by about 1965. It is being speculated that the Rover rocket will be used as a third stage for a Saturn-type booster-rocket combination. According to AEC, ceramic-coated uranium beads may provide a break-through for various uses, and the nuclear rocket may be among them. Alumina coating can keep down dangerous fission products.

Recently the Kiwi A3 reactor was used in a Rover test. A successful run of over fifteen minutes at full thrust was reported. It has been stated that the ultimate specific impulse of 700 seconds will be achieved in a 200-megawatt configuration. This would put the performance at about twice the level of our best present chemical combination—hydrogen and oxygen.

X-15 Engine.—Tests of the new 50,000-pound-thrust engine for the X-15 high-altitude rocket plane have been successful. The engine will be used to propel the aircraft to speeds of around 4,000 miles an hour to the limit of the atmosphere. The engine can be throttled down to 25,000 pounds of thrust, if necessary. With a dry weight of around 900 pounds, the engine is capable of operation at temperatures of minus 65 to plus 165 degrees Fahrenheit, and burns liquid ammonia and liquid oxygen.

The engine can be used time and time again, and the overhaul time is about one hour. However, in 1,200 ground tests, some 11 hours have been logged on the same engine. The engine also might be modified to use higher-energy propellants and could then develop some 100,000 pounds of thrust.

Two future applications mentioned as possibilities for the engine are an air-launched manned vehicle from the B-70 or a ground-launched Dyna-Soar rocket glider. In addition, with such an engine in a stage atop a Nova-class booster it could land a man on the surface of the moon and bring him back to the earth.

Army Gets Liquid Facilities.—Picatinny Arsenal has taken over the former Naval Air Rocket Test Station at Lake Denmark, N.J. The $12 million turnover gives the Army Ordnance Corps 215 buildings located on 760 acres of land, and it will put the Army into the liquid-rocket business. Former Navy and civilian personnel have transferred over to the Army.

One of the biggest items that the Army received is a static test stand capable of handling a 350,000-pound-thrust liquid rocket. Several other stands, capable of testing solid and liquid engines of 10,000- to 100,000-pound thrust also are added. Other facilities include environmental test areas, workshops, and liquid-propellant storage areas.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

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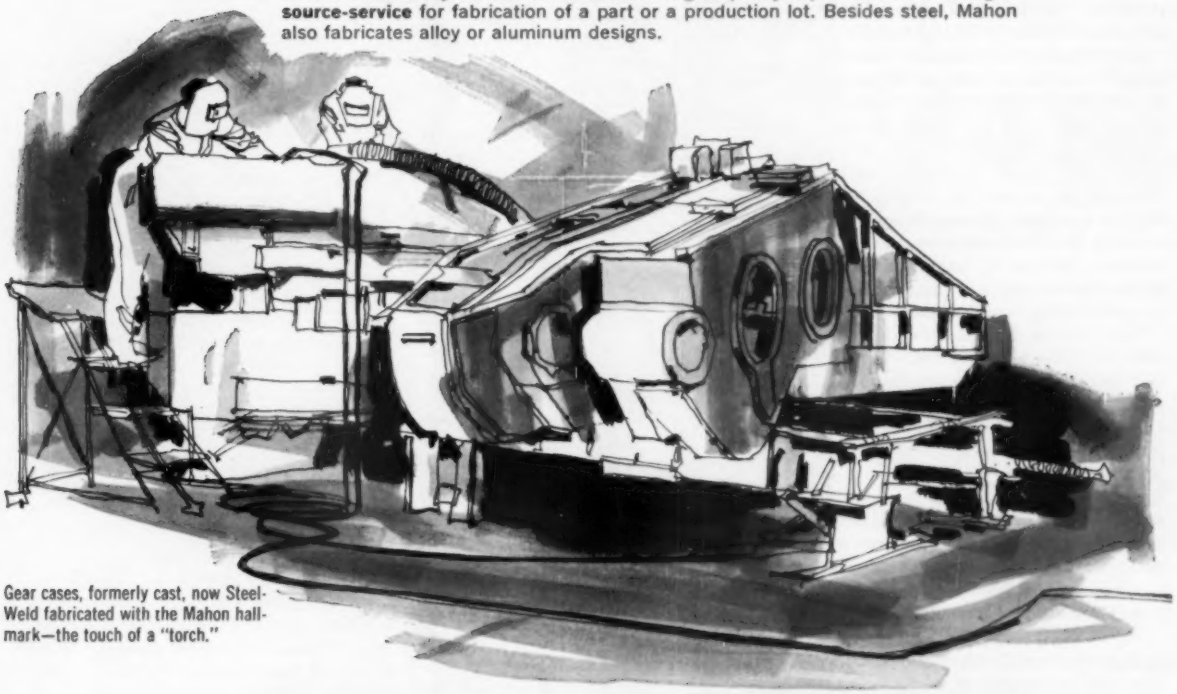

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SPACE ARMAMENT

Satellites' Spin Stopped

Navy scientists have succeeded in virtually stopping the rotation of two satellites orbiting in space. This new achievement was accomplished on the Transit I-B navigational satellite and later repeated on the Transit II-A satellite by using the earth's magnetic field as a brake.

A satellite is made to spin when it is launched into orbit in order to stabilize its motion just as a rifle bullet is made to spin to cause it to fly straighter. Ultra-high stability radio transmission requirements for Transit, however, made it necessary to reduce the satellite's spin rate to less than one revolution in 100 seconds. These requirements were met and even exceeded by despin rods in each of the Transit satellites. Thus undesirable frequency noise was eliminated.

The Transit I-B satellite, placed in orbit on April 13, 1960, used mechanical and magnetic devices to stop spin. As a result, 14 days after being launched from Cape Canaveral with an initial rotation rate of 2.8 revolutions a second, the satellite's rotational rate was decreased to less than one revolution in 250 seconds. The spin of the Transit II-A, launched on June 22, 1960, was reduced only by magnetic rods. Twenty-five days after the launching the rotation rate was less than one revolution in a thousand seconds.

As the satellite spun in the earth's magnetic field, the rods were magnetized first one way and then the other. Changing the direction of magnetism caused internal friction in the rods. This required energy which had to come from the spin of the satellite. As more and more of the satellite's spin energy was removed, the satellite's rotation rate decreased until it virtually stopped.

The magnetic rods are one-eighth inch in diameter and weigh only a few ounces each, yet they are able to stop the spinning of satellites weighing over 250 pounds.

Meteorological Satellite

A 280-pound meteorological satellite, Tiros II, recently was placed into a circular orbit 415 miles above the earth. Primary satellite instrumentation consists of two television cameras to photograph cloud cover and infrared sensors to map radiation in various spectral bands. With the exception of the infrared equipment, this space craft is similar to Tiros I (television and infrared observation satellite—see photo on front cover). Traveling at nearly 17,000 miles an hour, the satellite is circling the earth about every 98 minutes.

A joint program to test and evaluate the utility of cloud pictures received from Tiros II has been implemented by the Department of Commerce Weather Bureau and the military weather agencies of the United States.

The program consists of three phases: data reduction and interpretation, dissemination to the forecaster, and an appraisal by the forecaster of the value of these data to the solution of analysis and forecasting problems. Experience gained during Tiros I has gone into the development of this program to use satellite pictures on an experimental basis.

Project Apollo Studied

The National Aeronautics and Space Administration has selected three contractors to conduct individual feasibility studies of an advanced manned spacecraft as part of Project Apollo—the name given the next development effort in manned spacecraft after Project Mercury.

Three studies are being made to provide a variety of viewpoints. The firms selected from among those which submitted proposals are: Convair Astronautics Division of General Dynamics Corporation, the General Electric Missile and Space Vehicle Department, and the Martin Company.

Project Apollo plans call for a versatile spacecraft that will greatly extend man's capabilities to explore and experiment in space. It will provide the capability for manned reconnaissance flights to the vicinity of the moon as a logical step toward future goals of landing scientific teams on the moon and exploration elsewhere in the solar system.

Project Apollo's proposed multimission capability will include a variety of scientific, technological, and civilian services as an earth-orbiting vehicle. It also will serve as an intermediate step toward the establishment of manned space stations.

Space Observatory

Grumman Aircraft Engineering Corporation, Bethpage, N. Y., will develop a 1½-ton orbiting astronomical observatory (OAO) for the National Aeronautics and Space Administration. Astronomers will use telescopes in the OAO space platform to study cosmic phenomena—X-rays, ultraviolet and infrared rays—obscured to ground observatories by the earth's atmosphere.

The 8-sided satellite will be 9½-feet high and 6½-feet in diameter and will weigh about 3,200 pounds including 1,000 pounds of experimental equipment.

The spacecraft will be a standardized shell containing stabilization, power, and telemetry instruments into which one or more separate experiments can be fitted for each flight. Astronomical equipment with reflecting mirrors up to thirty-six inches in diameter will be mounted in a cylindrical chamber running through its length.

NASA plans to launch the first OAO in late 1963 from the Atlantic Missile Range into a 500-mile circular orbit with an Atlas-Agena B vehicle. It will have a stabilizing system to "lock" astronomical equipment on the star, sun, or planet it is observing. Using its fine pointing control, it will be able to track a star with an accuracy of one-tenth of a second of arc.

A satellite command system will receive ground signals to point and operate the satellite and its experiments, and a television tube will transmit pictures to ground stations to verify the direction in which the satellite is pointed.

The telemetry system to transmit information from the experiments and on satellite operating conditions will send digital data and television signals on wideband and information on experiments and monitors of the satellite's condition on narrow-band.

Semiautomatic Network

The worldwide network of satellite Minitrack stations and the Goddard Space Flight Center of the National Aeronautics and Space Administration were linked together recently in a new semiautomatic communication system. The new system, installed by Western Union, will permit faster, more flexible transmission of information from Minitrack stations and data users associated with the network to the Space Control Center of NASA.

It also will make possible the transmission of a larger volume of messages at faster speeds than the previous completely manual system.

Administrative messages, statistics, tracking, and launch information, as well as interagency communications, will be handled at the rate of 130,000 words an hour by the new system.

He solved this puzzle by taking it apart!

Like oil and water, extreme precision and "complete" mobility resist combination in tracking radar antennas. Designing for one of these characteristics "automatically" precludes the other. *That* was this AMF Engineer's puzzle—to put *both* precision *and* mobility in an antenna for duty with the Marine Corps.

He solved the puzzle, literally, by taking apart the solution—AMF's TPQ-10 antenna—into 10 rugged, portable, submersible, precision-fabricated packages. TPQ-10 is designed for helicopter transport. Each component can be dropped in water; it will come up for more. The packaged antenna on its pallet can be dropped on land from 3 feet without impairing precision.

Each component can be *picked* up—the largest weighs 425 lbs.—and can be handled by 3 men. A crew of 6 can put TPQ-10 together in 20 minutes with one standard wrench.

Among the design innovations that solved the puzzle is a "piggyback" gear arrangement that puts both azimuth and elevation drives in one package. Result: almost half the parts and weight of separate components. Precision fabrication is typified by the reflector arms, held to a .005" deviation over 45 inches!

(For unclassified information on early warning and radar antenna systems, write Dept. CS 1, address below.)

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ARMAMENT ELECTRONICS

Traver B. Van Vliet

Advent Repeater Satellite.—Launching of the Advent communications repeater satellite has been scheduled for 1963. The 1,000-pound vehicle will be launched to an altitude of 22,300 miles by an Atlas ICBM. At this altitude, the time it takes Advent to orbit will be the same as the earth's own rotational speed. Thus, the satellite would be within line of sight of one third of the earth at all times. Three or four Advent satellites would be sufficient to provide communications cover for the entire globe. Advent will be an advanced version of the Courier communications repeater satellite put into orbit in October.

Microwave Oscillator.—A miniature oscillator using a tunnel diode has been developed by Radio Corporation of America. The oscillator produces 0.7-milliwatt output at frequencies ranging from 100 to 1,400 megacycles.

Orbital Scatter Communications.—"Orbital scatter communications," a technique involving the use of tiny metal whiskers to form an orbital radio reflector, has been disclosed by Lincoln Laboratory under sponsorship of the Defense Department. The metal whiskers, about 0.8-inch long and less than one-thousandth of an inch thick, will soon be ejected from a satellite as it circles the earth. The laboratory has been investigating the technique along with Thompson Ramo Wooldridge, Inc.

Saturn's Surface Temperature.—Under contract from the Office of Naval Research, scientists of the University of Michigan have recorded the surface temperature of Saturn to be minus 280 degrees Fahrenheit. The scientists used a radio telescope with a ruby maser amplifier to record the temperature. The signals received were the first from that planet.

Emergency Communications.—The Air Force is considering two more sophisticated versions of the Tattletale rocket-borne emergency communications system which would replace destroyed or blacked-out ground communications in case of attack. One system uses a rocket-launched repeater for a ground-air-ground link. The other is an emergency positive control communications system which involves the use of an aircraft-transported recorded message for wide coverage. The Tattletale communications system was designed by Wright Air Development Division and was built by Hughes Aircraft Company.

SNAP 8 Nuclear Power System.—Power rating of the SNAP 8 nuclear space power system, previously thirty kilowatts, has been increased to thirty-five kilowatts. The power-conversion system is being developed by Aerojet for the National Aeronautics and Space Administration and the reactor system by the Atomics International Division of North American Aviation, Inc.

Third Radiation Belt.—According to data obtained from Lunik II, Russian scientists believe that there is a third radiation belt around the earth, well beyond the two Van Allen radiation belts. According to Soviet reports, the belt is a plasma which is part of the earth's corona rather than an interplanetary gas.

Long-Range SAGE.—Higher-power transmitters and higher-gain horn antennas will be used by the Air Force to increase the range of the SAGE air-defense data-link communications, used to direct manned interceptors and Bomarc missiles. The program is expected to cost about $25 million.

TARAN.—A new aircraft electronic system that enables a fighter-bomber to fly hedge-hopping missions in adverse weather and to avoid detection by darting in below an enemy's radar cover has been developed by Hughes Aircraft Company and was disclosed at the William Tell 1960 Tactical Fighter Meet. The system, called TARAN (tactical attack radar and navigator), will make it possible for tactical aircraft to operate by electronic control much as all-weather interceptors. The system has three basic capabilities:

1. Navigation.—TARAN will navigate automatically out to a target and back in any kind of weather, day or night. It continuously shows the pilot his position by a symbol on a moving map displayed on a screen in the cockpit.

2. Air-to-ground attack.—A new high-resolution radar enables the pilot to pick out ground targets through dense fog or overcast.

3. Air-to-air attack.—The system can perform the search and track functions required to locate an enemy aircraft, and it will launch either radar or infrared air-to-air guided missiles.

High-Power Klystrons.—Now under construction by Eitel-McCullough is a klystron power supply which will permit power levels fifteen times that required for existing tubes, already with peak power levels of tens of megawatts. Average power output of the supply will be three megawatts at 282,000 volts.

Space Batteries.—The Department of Defense will initiate through the Advanced Research Projects Agency a research and development program in space batteries. The program is the result of an effort to obtain better quality nickel-cadmium batteries for missile and space-vehicle use.

Airborne Electronics.—A contract for production of the AN/ASQ-19, an advanced airborne electronics system, has been awarded by the U. S. Navy to Packard Bell Electronics Corporation. The integrated electronics system, which combines communications, TACAN, navigation, and identification, is carried in four Navy aircraft: the North American A3J Vigilante, the McDonnell F4H-1 Phantom II, and the Grumman W2F-1 Tracer and A2F-1 Intruder. The entire electronics central is composed of replaceable plug-in modules, a construction concept replacing conventional electronic circuitry used in its predecessor, the AN/ASQ-17B.

Radio Telescope.—The largest radio telescope in the world, with a disk one thousand feet in diameter, will be constructed in Puerto Rico under sponsorship of the Advanced Research Projects Agency. The antenna will be constructed in a natural limestone bowl, and by moving the feed point it will cover a cone of forty degrees. The telescope will operate at a frequency of 400 megacycles with a peak power of 2½ megawatts. It is due for operation in July 1961.

Mr. Van Vliet is a student of engineering and mathematics. He is active in amateur radio and also in experimental electronics.

BOOK REVIEWS

Reviews in this issue by:

LOREN BOLLINGER, *aeronautical engineer, assistant professor, Ohio State University, Columbus, Ohio.*

LEO A. CODD, *editor, Washington, D. C.*

DR. JAMES B. EDSON, *senior assistant for missiles and space, Office, Assistant Chief of Staff, Army Intelligence, Washington, D. C.*

COL. G. BURLING JARRETT, *engineer, ordnance expert, armament collector, Aberdeen, Md.*

COL. A. C. LAZURE, *general counsel, Ordnance Corps, United States Army, Washington, D. C.*

COL. CHARLES MCKNIGHT, *ordnance engineer, metallurgist, historian, and former company executive, Fork, Md.*

MAJ. GEN. EDWARD P. MECHLING, *ordnance engineer, aircraft armament expert, Washington, D. C.*

COL. GEORGE F. MOTT, *consulting management engineer, political scientist, author, administrator, Washington, D. C.*

COL. VIRGIL NEY, *writer, educator, military historian, Silver Spring, Md.*

CAPT. J. M. P. WRIGHT, *naval ordnance engineer, logistician, editor, Washington, D. C.*

The Edge of War. By James D. Atkinson. Foreword by Adm. Arleigh A. Burke, Chief of Naval Operations. Chicago: Henry Regnery Company. 318 pp. $6.

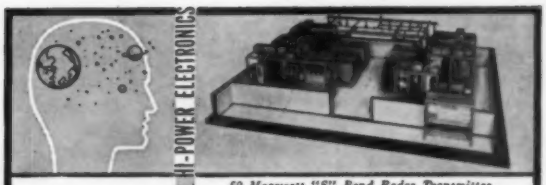
THE Communist conspiracy to rule the world is portrayed in this masterpiece in all its cunning and all its brashness. Admiral Burke writes in the foreword that he is "in agreement with Dr. Atkinson's general thesis and especially his observation that 'warfare of the latter part of the twentieth century is, above all, a battle of the spirit, of ideas, and of the human will.' This battle will be fought in the hearts, in the minds, and in the souls of men everywhere. It is hoped that this book will serve to awaken many to this fact." With the admiral's appraisal and his hope, this reviewer is in complete accord.

Dr. Atkinson has earned his widespread reputation as scholar and soldier. He is associate professor of government at Georgetown University, Washington, D. C., and commands an Army Reserve unit with the rank of colonel.

It is a very timely service the author renders in revealing again how the Communists' waging of war is camouflaged as a drive for peace.

Dr. Atkinson's concern—and it should be shared by every thinking American—is our own inexperience in unconventional warfare. We are clumsy in our waging of cold war. We are easily led astray. We live by the headline of moment. We forget the lesson of a year ago and are oblivious to the experience of a decade ago.

The fact that we are still armed to the teeth defending a desolate line in Korea is no longer of concern to the man in the street. The fact that we must continue year after year to be harangued at Geneva about the resumption of nuclear testing is of no consequence to our young men and women who are



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A.O.A. DIRECTORY AND INDEX

- The Annual A.O.A. Directory for 1960-1961 is still available. It contains rosters of the national Council, officers and directors, and advisory board of the Association. It also shows the officers and directors of each local A.O.A. Post and the members of the national Technical Divisions and Sections. The Directory also includes the Honor Roll of the Company Members of the Association, and an organization chart of the national society. It is available to A.O.A. members only.

- The Index to Volume XLIV of ORDNANCE also is available. It is arranged alphabetically by subject and author with title page for binding and covers issues No. 235 (July-August 1959) to No. 240 (May-June 1960) inclusive.

- Address requests to:

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bothered only by yesterday's dialogue in the United Nations.

All these futilities and frustrations are Communist victories according to Communist well-laid plans. These have brought us to the frightening position in which we find ourselves today—the edge of war.

In this book it is clearly shown that we hold all the trumps which we do not use because of our national indecision. We have the means and the heritage, but we have grown soft and weak. Please God, we will awaken soon to our stupidity and fight the enemy with his own weapons.—LEO A. CODD.

Armor—A History of Mechanized Forces. By Richard M. Ogorkiewicz. New York: Frederick A. Praeger, Inc. 475 pp. $7.95.

THIS is a rewarding book, rich in the analysis of armored-force vehicles for their true worth as tools of war. Since all armored vehicles are extremely hard to compare, one with another, they must be analyzed carefully, for it is so easy to confuse a reader or student if one offers engineering praise for some feature of an armored vehicle, especially if a less efficient and accompanying design feature actually penalizes the other.

The complexity of the topic is formidable. Yet this is the first time a factual, comprehensive, and chronological account of armored vehicles has been attempted.

The book sets forth the technical side of the problems which the driver, gunner, and tank commander present to the designer. In addition, the historical incidents, the battles, and the temperaments of those involved are given proper attention so that one gets a certain amount of "feel" of the vehicle under discussion.

Many names of importance in the armor field such as Heigl, Swinton, Fuller, Liddle Hart, and others run through the pages of this work. These people not only specified what they sought in an armored vehicle but also laid out the tables of organization upon which units were set up to utilize the armor they envisioned. Each one offered a different tank type as well as the organization to man it, and it is little wonder that the topic is complicated. —G. BURLING JARRETT.

The Hidden Russia. By N. N. Krasnov, Jr. New York: Holt, Rinehart and Winston. 341 pp. $5.

THE author tells here only what he experienced. His account of Soviet Communism in action as it accommodates itself to moral neutralism, unrelenting planned depravity, and its own brand of scientifically contrived sadism as practiced in the prisons and labor camps of the U.S.S.R. where he was held for years is part of the story as it unfolds.

However, the great value of the book —the reason it should be read by citizens of the free world everywhere—lies in the inherent effectiveness of its truth. This is a most dangerous book to the Communists in Russia and to their fellow travelers throughout the world. The facts related in it are appalling.

To the Russian people, as well as to ourselves, Communism is the enemy. If we identify the Russian people with the Kremlin and fellow travelers in other lands, we are lessening our hope of a constructive solution in the future. The identity of the real enemy is made so plain by Mr. Krasnov's story that no doubt is possible. At this moment, there may be no diplomatic use to be made of the knowledge, but, realizing the difference between Russians and Communists, and knowing about this great growing state within a state nurtured by the Soviet prisons and labor camps, we must not forget it.—GEORGE F. MOTT.

The Public Years—Volume II of My Own Story. By Bernard M. Baruch. New York: Holt, Rinehart and Winston. 431 pp. $6.

IT can be said with complete accuracy, I think, that no living person surpasses Bernard M. Baruch in experience, study, and leadership in all phases of industrial preparedness. Now in his ninetieth year, keen of mind and deep in wisdom, he began his public service in 1917, under the presidency of Woodrow Wilson, as a member of the President's War Cabinet.

In three great wars in which our country has been engaged, Mr. Baruch's experience as economist, financier, administrator, and diplomat has made an enduring mark. To him goes a large share of the credit for developing the science to which the American Ordnance Association is dedicated: Industrial preparedness for war as one of our Nation's strongest guaranties of peace.

Naturally enough, all members of the Ordnance fraternity will be enthused about what Mr. Baruch has written—particularly his pioneering in the first World War—and will express anew their admiration and gratification for his service to his country and his fellow man.

There are many episodes in "The Public Years" worthy of mention in this review. Two are especially significant:

First is the organization of the War Industries Board in World War I. Its counterparts in succeeding emergencies were made up of commodity divisions and sections—and today such is the organization of the Ordnance Association's technical operations. Services by industries and their representatives on W. I. B. were voluntary; so it is today with the Ordnance Association.

The second episode relates to Mr. Baruch's description of his experiences before the Nye Munitions Committee of the U. S. Senate in 1934-1935. It was a disgraceful proceeding engineered in part by one Alger Hiss, who was counsel to the Committee. The Senator and his associates preached the cockeyed theory that war was the result of "munitions makers' " thirst for profits and that these men were "merchants of death."

Nye and Hiss, with agitating techniques used today by the Communists, damned one and all who defended the role of American industry in the First World War. The Ordnance Association—like Mr. Baruch, a defender of the faith—also received violent attack from the same sources.

But Mr. Baruch in his activities and the Association in its—both being devoted to the national defense of their country—had nothing to hide. Neither could be frightened by threat of the agitator or the furor of the journalists.

New in the public record of this disgraceful phase of our Nation's history is a letter from former President Truman to Mr. Baruch dated May 5, 1958 (thirteen years after the event). Mr. Truman, an eyewitness, accurately appraised the results of the Nye-Hiss operations in these words:

"I think the Nye Committee did more damage to the morale and welfare of this country than any other Committee that held hearings in the Senate. It was fundamentally the cause of our continued isolationist program and contributed more than any other one thing to our complete unpreparedness when World War II broke. I happened to be in the Senate while those hearings were going on, and I know what I am talking about."—LEO A. CODD.

International Missile and Spacecraft Guide. By Frederick I. Ordway, III, and Ronald C. Wakefield. New York: McGraw-Hill Book Company. 411 pp. $25.

THIS is a massive compendium of the world's missiles and space vehicles that equals Janes' well-known "Fighting Ships" in its orderly presentation, excellent photographs, and factual information.

In addition to description of each missile, arranged by categories (air-to-surface, etc.) for every nation, there is much other useful information. The authors have included comprehensive accounts of the early development work in all countries and also full descriptions of test vehicles and research rockets.

Most useful are the worldwide listing of all government agencies, industries, and societies involved in missile or spacecraft development, and a bibliography.

It is an invaluable reference work for every organization concerned with this fast-moving field.—J. M. P. WRIGHT.

(*Continued on p. 564*)

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Book Reviews (Contd.)

Storming of the Gateway. Chattanooga, 1863. By Fairfax Downey. New York: David McKay Company. 303 pp. $5.50.

TAKING the Civil War tide at its Centennial flood, Colonel Downey presents his third Civil War book in as many years. This volume describes battle action of the combined arms (infantry, cavalry, artillery) in a campaign of three major battles, best described as "the fighting around Chattanooga."

Although not recognized at the time as being important, this series of battles and a siege stands out as one of the crucial campaigns of the war.

Colonel Downey follows closely the pattern he set in "The Guns at Gettysburg" and "Clash of Cavalry" as he relates in his informal and unorthodox way the story and the history of the struggle around Chattanooga. He is at his best in bringing to life again the dusty figures from the past and letting them speak. The reader feels on intimate terms with the curmudgeon Bragg and the infantile Johnny Clem and shares with Phil Sheridan that moment of exultation as he takes a pull from his silver flask and toasts the Confederates, gallant in defeat.

Now Colonel Downey turns his words into action as he leads the reader up the slopes of Snodgrass Hill where Thomas saves the Army of the Cumberland from rout and disaster, then on with Hooker's men as they clear the Confederates from the steep flank of Lookout Mountain and make possible the climactic Soldiers' Battle, when the Union troops, without orders or officers, determined and furious, swarm over the palisaded crest of Missionary Ridge and open the gateway to the South, lying before them, ripe for the plucking.

All his own writing is of the superior quality we have come to expect from this skillful military scholar and historian, but, unfortunately, too large a part of the book is not Colonel Downey's writing at all and many pages are given over to incomplete, immaterial, or superfluous reprinted matter.

This book is recommended by the Company of Military Collectors and Historians as a graphic and absorbing account of one of the most significant campaigns of the Civil War.—CHARLES MCKNIGHT.

American Strategy for the Nuclear Age. Walter F. Hahn and John C. Neff, editors. New York: Doubleday & Company. 455 pp. $1.45 (paperback).

THIS important volume is published in paperback form with the object of reaching a large number of readers quickly. Published under the auspices of the Institute for American Strategy and prepared under the direction of the Foreign Policy Research Institute of the University of Pennsylvania, this is a worthy effort to alert America to the dangers it faces and the steps it must take to survive.

The material is presented in thirty-three articles by eminent authors, and the presentation is arranged in six parts. Part one analyzes our position in the current protracted conflict. Parts two and three illuminate Communist capabilities, objectives, strategies, and tactics. Parts four and five deal with military and economic strategy. The last part gives some views on the responses we should make to the challenge.

While all facets of the Communist threat and our reactions are discussed, the recommendation that the United States and its allies initiate and pursue a strong program of private enterprise and individual freedom is repeatedly emphasized. Emphasis is also given to the view that we must carry out strong, well-balanced programs in all areas of the protracted conflict if we are to succeed. This would include the ideological, psychological, technical, military, and economic aspects.

While there is agreement that we must have the military strength to deter overt aggression there are also repeated recommendations for greatly improved psychological propaganda and other infiltration tactics.—EDWARD P. MECHLING.

Why the North Won the Civil War. Edited by David Donald. Baton Rouge: Louisiana State University Press. 129 pp. $2.95.

THE dust jacket, complete with a list of Civil War books, announces that "In this volume five of the country's leading Civil War scholars offer new and unique insights into this perennially fascinating question—Why did the North win the Civil War?"

Maj. Gen. U. S. Grant, III, in his excellent and timely foreword, has this to say: "Each of the articles here assembled is an authoritative discussion of one of the factors that militated against the Confederacy's final victory. Moreover, these factors, presented from the over-all point of view, too generally have been inadequately stressed or even entirely overlooked by many histories of the war. In now bringing these factors to public attention and giving them their proper emphasis lies the importance of this book. Even many 'Civil War buffs' may be apprised of facts of which they have heretofore been unaware or to which they have given little thought."

Each of the separate chapters covers the fields of economics, military leadership, diplomacy, statesmanship, social structure, and political leadership. Of necessity, there is an opportunity for comparison between the North and the South in relationship to the above activities, and the authors make effective use of it.

While this objective and nonpartisan volume treats only of the Civil War and the loss of the war by the Confederacy, its conclusions, based upon sound historical research, are ageless.—VIRGIL NEY.

Guide to the Space Age. By C. W. Besserer and Hazel C. Besserer. New York: Prentice-Hall, Inc. 320 pp. $7.95.

SPACE technology together with missiles and rockets has spawned a whole new vocabulary. Old words and phrases take on new meanings where new words are not employed.

These authors have compiled over 5,000 space terms and their meanings in this volume ranging from A to Zuni. Basic technical terms, ordinary words applied specially to the aerospace field, abbreviations and acronyms, vernacular terms, and names and descriptions of the various craft all are listed.

For those having any connection with space, missile, or rocket ventures, "Guide to the Space Age" will be of great assistance to elucidate the vocabulary in this rapidly expanding field.—LOREN E. BOLLINGER.

Conflict of Interest and Federal Service. By the Association of the Bar of the City of New York. Cambridge, Mass.: Harvard University Press. 330 pp. $5.50.

THIS report by a Special Committee of the Association of the Bar of the City of New York examines and discusses conflict of interest laws, regulations, decisions, and rulings in the Executive Branch of the Federal Government. The 10-man committee, headed by Roswell B. Perkins, and with a staff consisting of Bayless Manning, professor of law, Yale University, and Merver H. Berstein, professor of politics, Princeton University, has very adequately presented the Federal conflict of interest problem, discussed its background, and recommended solutions.

As stated in the opening chapter, the book has two themes—the ethical standards in the Federal Government must be beyond reproach and the Federal Government must be in a position to obtain personnel and information it needs to meet the demands of the twentieth century.

The scope of the book includes an analysis of statutes enacted in the area beginning with the post-Civil War period, illustrating how the various statutes were enacted from time to time to meet a particular evil or scandal. Statutes are discussed in four categories—conflict of interest statutes; postemployment statutes; outside compensation statutes; and exemptions. There is also a discussion of

regulations of the various departments and agencies in the conflict-of-interest field and the effect on hiring and other personnel actions.

This book, although a scholarly study, is not fundamentally a legal textbook, but rather a handbook which might be used profitably by an executive serving the Government as a full-time employee or consultant.

The last chapter sets forth a comprehensive bill proposed by the committee in this field, entitled "Executive Conflict of Interest Act," to apply to the 2,300,000 Federal employees, regular and intermittent, and to the 2,600,000 members of the armed forces.

Of particular interest to A.O.A. members is the treatment by the Senate of Presidential nominees seeking confirmation, showing what stock divestiture was required, and what business interest and stockholdings might be retained.—A. C. LAZURE.

Men of Space. By Shirley Thomas. Philadelphia: Chilton Company. 235 pp. $3.95.

TEN paths to accomplishment are outlined in these brief biographies of well-known "men of space." Varied indeed in talent, temperament, and social background are such people as Tsiolkovsky, Van Allen, Stapp, Goddard, and Von Braun. This must needs be so, for astronautics knows few boundaries of technique and none of geography. Yet in nine of the ten there is a common factor, the common key that unlocked the potential of greatness in each mind and heart.

Each was blessed with parents who loved and pursued the path of learning. And each parent, with devoted zeal, sometimes at great sacrifice, early opened for the young child that high ascending road of long labor and of endless unfolding wonder. It was the strong early start upon the way of knowledge that at last gave to each of them the power to reach for the stars.

Gentle (but busy) reader, have you and I done as much for our children? Upon the answer truly depends the future of America.—JAMES B. EDSON.

BOOKS RECEIVED

Aero Mechanic's Questionnaire. By Ralph Rice. Los Angeles: Aero Publishers, Inc. 203 pp. $6.50.

Can We End the Cold War? By Leo Perla. New York: Macmillan Company. 251 pp. $4.50.

Danish Resistance, The. By David Lampe. New York: Ballantine Books, Inc. 179 pp. $0.50 paperbound.

Electronic Maintainability, Vol. III. Edited by F. L. Ankenbrandt. Elizabeth: Engineering Publishers. 312 pp. $10.

Elements of Maser Theory. By Arthur A. Vuylsteke. New York: D. Van Nostrand Company. 362 pp. $9.50.

Embrittlement by Liquid Metals. By William Rostoker. New York: Reinhold Publishing Corporation. 162 pp. $7.95.

Flexible Shaft Handbook. Fourth Edition. New York: S. S. White Industrial Division. 89 pp. NP.

Flying Saucers and the U. S. Air Force. By Lieut. Col. Lawrence J. Tacker. New York: D. Van Nostrand Company. 164 pp. $3.50.

Illustrated Hunters Handbook. Washington: National Rifle Association. 128 pp. $3.00 to nonmembers; $2.00 to members.

International Dictionary of Applied Mathematics. Edited by W. F. Frieberger *et al.* New York: D. Van Nostrand Company. 1,173 pp. $25.

Management Guide for Maintenance Supervisors. By Bernard T. Lewis and William W. Pearson. New York: John F. Rider Publisher, Inc. 64 pp. $1.25.

Management Guide for Preventive Maintenance. By Bernard T. Lewis and William W. Pearson. New York: John F. Rider Publisher, Inc. 64 pp. $1.25.

Management Guide for Production Control. By Bernard T. Lewis and William W. Pearson. New York: John F. Rider Publisher, Inc. 72 pp. $1.40.

You Have To Pay the Price. By Earl H. Blaik with Tim Cohane. New York: Holt, Rinehart and Winston. 430 pp. $4.95.

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POSTS OF THE AMERICAN ORDNANCE ASSOCIATION

THE local Posts and Chapters of the Association are the essential centers through which members keep in personal contact. They provide executives, engineers, and scientists in both industry and the military with a more intimate understanding of our weapons needs and progress, and with the opportunity to meet and exchange ideas and information. In addition, Posts create interest in the Association throughout their area and also maintain a close relationship with the local defense establishments concerned with ordnance and industrial preparedness.

Forty-one Posts and thirteen Chapters, mainly concentrated in the larger industrial centers, cover the entire geography of the United States. Each of the more than 43,000 members of the Ordnance Association is also a member of the local Post within whose territory he resides.

Functions of A.O.A. Posts and Chapters may be compared to those of a local unit of an engineering and technical society. Meetings feature top military and industrial speakers, technical seminars, plant visits, movies, and tours of military establishments—activities designed to provide members with added knowledge of today's armament and defense problems and progress.

Through such widespread local activity, plus A.O.A. technical operations and specialized armament publications, the Association makes an invaluable contribution to America's industrial preparedness and weapons readiness.

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

The Modern Minuteman

Our newest solid-propellant ICBM will be ready for fast action

Col. Carlo R. Tosti, U.S.A.F.

Deputy Chief, Ballistic Missiles Branch, Office, Deputy Chief of Staff, Development, United States Air Force, Washington, D. C.

IN 1776 the militia of the American Revolution, ready for service at a minute's notice, were known as the Minutemen. Today, almost two centuries later, an inanimate Minuteman is being developed to serve the same purpose—to stand ready in the defense of American freedom.

The Minuteman ICBM, being developed by the United States Air Force, represents the latest in the science and technology of military weapons. It is a 3-stage, solid-propellant, intercontinental ballistic missile weapon system. The missile will have a range of 6,300 statute miles (5,500 nautical miles) and will deliver a nuclear warhead at speeds of more than 15,000 miles an hour. And, true to the spirit of '76, it will be ready for action at only a moment's notice.

THE keynote of Minuteman design is simplicity and low cost. Through simplicity, complex ground support and checkout equipment and facilities and skilled manpower requirements will be drastically reduced. Further, as compared with the large, liquid-propellant ICBM's, the Atlas and Titan, it will be considerably cheaper to produce. In short, Minuteman is a system designed for high reliability, capability of survival after enemy attack, maximum simplicity, decreased reaction time, and greatly improved cost effectiveness.

In the words of Lieut. Gen. B. A. Schriever, Commander of the Air Research and Development Command; "This missile . . . will mark the first case where a more effective weapon will be produced at a lower cost than its immediate predecessors. It is my firm belief that the low cost, the mobility, and the capacity for swift reaction, which can be achieved by Minuteman in large numbers, will ensure that the United States will retain the power to make an attack on the free world too great for an aggressor. This is why Minuteman—as an economic break-through—is of such great importance."

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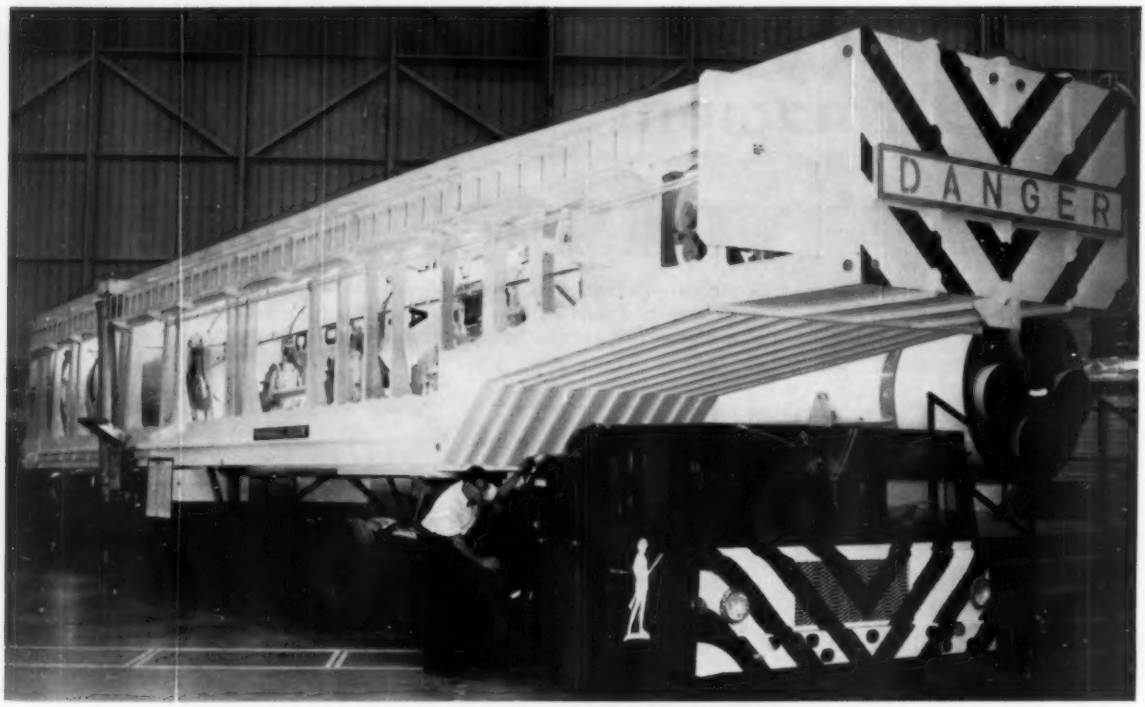
A new environment

THE Minuteman is being developed within the Air Force under the technical direction of the Air Force Ballistic Missile Division of the Air Research and Development Command. Selection of solid-propellant rockets for the Minuteman was based on the very desirable operational characteristics of these propellants and the requirement for no on-site propellant-handling equipment and long engine storage life.

Minuteman missiles will be deployed in two configurations—fixed and mobile. In the fixed configuration, the missiles will be placed in concrete underground silos and will stand on the ready there for many months without requiring major maintenance or removal. During this period they will be monitored constantly by an underground control center which, if di-



Adding further mobility to the Minuteman ICBM is the self-propelled transporter erector, designed to be airlifted with missile in place (AF photo).

rected, could launch them at their targets immediately.

The concrete and steel-lined silos will be dispersed and hardened to withstand the shock of a nuclear attack on the area. Interlinking communications systems between various control centers and silos in the pattern of a Chinese checkerboard will permit the launching of these missiles from alternate control centers.

The first operational Minuteman intercontinental ballistic missiles will be positioned in hardened sites in the vicinity of Malmstrom Air Force Base near Great Falls, Mont. Three squadrons are programmed for deployment there. Each launch position or silo will require approximately two acres of land, plus the necessary easements to allow entry and the erection of communication and power lines.

CONSTRUCTION cost for each squadron is expected to be about $20 million with construction extending over a period of from 15 to 18 months after the award of the first construction contracts in mid-December 1960. Upon the completion of silo construction, Boeing will install and check out the ground support equipment necessary to the maintenance, countdown, and launch of the missile weapon.

Upon completion of the successful mating of the missiles to their launchers, the squadron will be in operational-readiness status and will be turned over to the Strategic Air Command. The first Minuteman is scheduled to be ready—in operational status—in mid-1962.

To further augment the capability of Minuteman survival against nuclear attacks provided by the hardening and dispersing of the fixed silo launchers, a portion of the Minuteman force will be deployed in a mobile configuration on railroad trains moving about the country. This tactic of movement further compounds the problem an enemy faces in attempting to destroy our defensive deterrent force. In effect, it greatly increases the number of targets with which he must contend.

These trains will travel over the Nation's vast rail network. They will be kept ready for launch for varying periods of time at specific rail points. At any given time, a portion of the mobile force will be ready for immediate launching while another portion will be traveling to new launch points.

To validate the mobile train concept, a series of six tests was planned to study the use of civilian rail facilities. The Strategic Air Command, in cooperation with other Air Force commands and the officials of more than thirteen railroads, began the first test in June 1960 operating from Hill Air Force Base, Ogden, Utah, where a special SAC task force had been activated to direct the test program. Commanding the task force was Col. Virgil M. Cloyd, Jr., former director of operations for SAC's 1st Missile Division at Vandenberg Air Force Base, Calif.

HE and his staff, working from a special command post at Hill Air Force Base, supervised the formation and maintenance of the test trains and coordinated all movements with civil rail traffic.

Each trip lasted from seven to fourteen days with several days' interval between trips to permit a thorough analysis of the different tactics under study. One tactic tried during the test program was to perform random movements between sidings which had been scheduled in advance of the trip. Another tactic called for the train to be moved to a specific siding over the best available trackage within a prescribed time limit.

To carry out these tests, the military

train crew consisted of about twenty-one men. Also aboard were observers from the Air Force Ballistic Missile Division, the Air Matériel Command, and various Minuteman contractors. Railroad representatives and crewmen also participated.

While the Strategic Air Command was the test operator and was responsible for all movement and communications operations, the Air Force Ballistic Missile Division served as test director and controlled all technical and scientific activities, and the Air Matériel Command furnished all supplies and other support needed for the test program through the Ogden Air Matériel Area at Hill AFB.

The Association of American Railroads and its member organizations furnished the locomotives and cabooses and civilian crews to operate the trains. The A.A.R. also served as a coordinating agency between the Air Force and the civil rail systems.

Other cars on the train were furnished by the United States Army Transportation Corps from existing rolling stock owned by the Department of Defense and being held in war reserve storage at the Ogden General Depot in Utah.

EACH test train was made up of about 14 cars, and included a command and control car with single sideband radio and ultrahigh frequency equipment linking the train commander with the task force command post at Hill AFB and the SAC command post at Offutt AFB at Omaha, Nebr. Other cars provided support for train personnel and storage space for the power-car fuel and supplies.

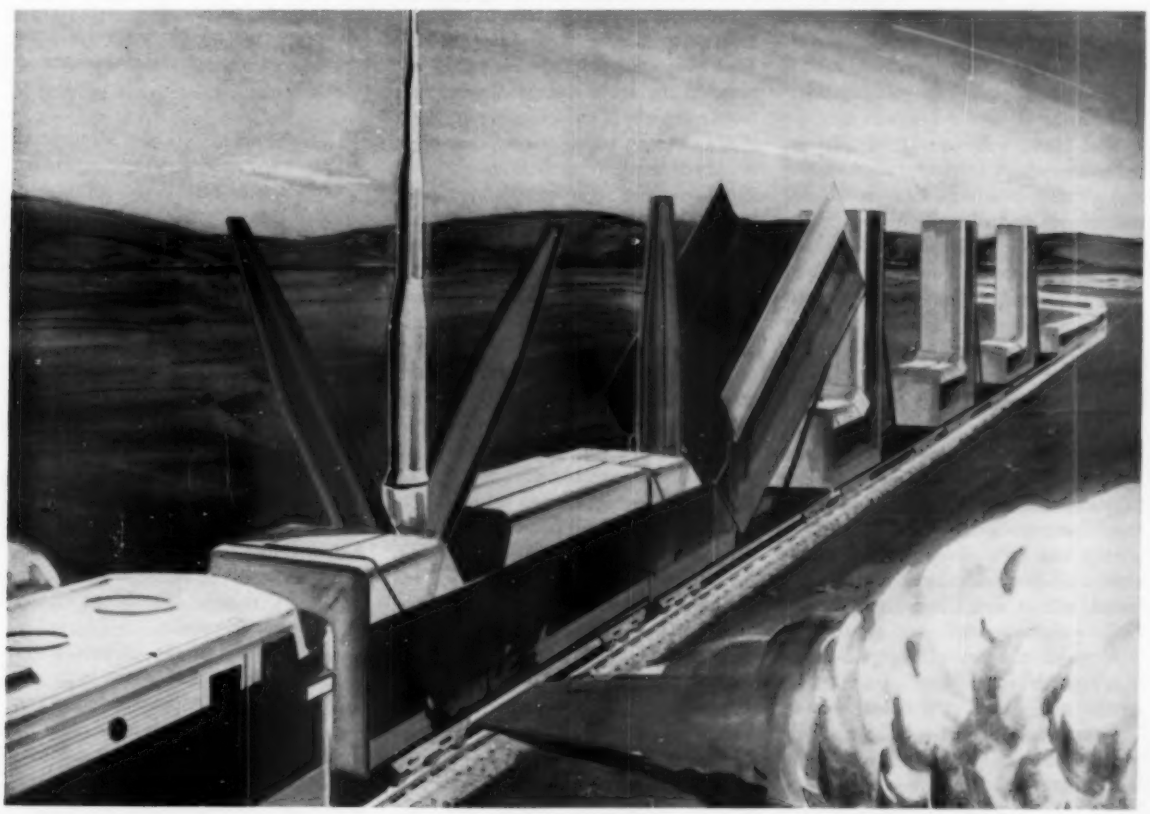
Typical of the test runs was the fourth Minuteman mobility test train which left Hill AFB on August 16, 1960, several weeks ahead of the original test schedule. Its 10-day trip took it through Utah, Nebraska, Colorado, Missouri, Iowa, and Illinois. During this run, train personnel made checkouts of control, mobility, and communications factors involved in planning future operations of a fleet of Strategic Air Command trains carrying Minuteman ICBM's.

Incidentally, after completing the fourth train exercise, the test program was terminated. Six runs had been planned initially, but sufficient information and experience were gained in the four runs to satisfy the Air Force that it can move and fire its solid-fuel Minuteman ICBM from almost any point along the thousands of miles of track in the U. S. rail net.

Gen. Thomas S. Power, SAC Commander in Chief, in announcing termination of the tests said: "We have found the test program completely successful in providing the information we need to make firm plans for the mobile Minuteman. The fact that we can terminate the program after four deployments also results in substantial savings to taxpayers."

In summary, the significance of the mobile Minuteman was expressed concisely by the Deputy Commander in Chief of the Strategic Air Command,

Drawing of proposed Minuteman missile train with five solid-propellant weapons in various stages of accelerated countdown and firing (AF photo).



Lieut. Gen. Francis H. Griswold, as follows:

"Our train with its missiles and crewmen will travel over the roadbeds of large areas of the countryside, but the pattern of movement will be unpredictable—possibly it will stand on a siding for hours before moving on. Control of the train will be positively maintained from the command post at SAC Headquarters. A crew will be on constant alert, and if the day comes when it becomes inevitable that we exchange fire with an enemy, the rail mobile portion of the SAC force will be prepared and capable to hit those targets assigned to it."

Basic to the successful use of Minuteman is the procedure for its assembly and delivery to the field. Assembly of the missile will be accomplished at centrally located sites under conditions conducive to precision assembly and checkout procedures.

First production Minuteman missiles will be assembled by the Boeing Airplane Company in an assembly facility at Hill AFB, Utah. Here, components of the missile, except for the reentry vehicle which carries the nuclear warhead, will be assembled and thoroughly checked out prior to being shipped to the dispersed underground launch sites or placed aboard the mobile train launchers.

The plant will consist of fifty-six structures which are being modernized and six new buildings. Construction of this plant began in September 1960, and the Boeing Airplane Company, which will operate the facility, will begin to install factory equipment in the summer of 1961. Most of the structures in the complex are required for the storage of the missile's three solid-propellant engines.

TO facilitate the delivery of engine stages, their assembly as complete missiles, and delivery of the missiles to their underground launchers, a unique system has been developed which includes all practical forms of transportation within the Continental United States—highway, rail, and air.

A major element of the transportation system is a large tractor-trailer combination called a transporter-erector. The transporter-erector will haul the missile from the assembly facility to the launch site and lower it into the silo. Inside the transporter-erector, where the temperature and humidity will be controlled, the missile will be cradled on a unique suspension system.

Larger than most tractor-trailer combinations, the transporter-erector is more than 63 feet long and weighs a little over 100,000 pounds when loaded. However, it has been designed in a manner which will enable it to travel over most of the Nation's main highways and bridges.

THREE companies are assisting Boeing, which has primary responsibility for the transportation system, in the development of the transporter-erector. General Motors Corporation is developing the tractor and carriages for the missile container. Cessna Aircraft Company will provide the missile container. Bendix-Pacific Division of Bendix Corporation is working on the hydraulic system for raising the missile container and lowering the missile into the silo.

The transportation system consists of engine harnesses, engine transporters, in-plant transporters and handling dollies, and the transporter-erector.

All of this equipment utilizes a rail transfer method in which the engine harness undercarriages ride on rails at a constant height above the ground. This allows for easy transfer of the individual engines or the complete missile from one piece of equipment to another.

A universal engine harness has been designed to adjust automatically to the various engine diameters and to accommodate missiles which might not be straight during the recycle phase. (The recycle phase is the removal of missiles from the silos and their return to the assembly facility for repair via the transporter-erector.) The harness also provides an elastic support for the missile while traveling.

Engine transporters will appear from the outside to be similar to many trucks seen on highways today. They will be adaptable to shipment by rail (piggyback) or by air. The trailer or van used during this stage will have, like the transporter-erector, a controlled environment and suspension system matching that of the engine harness. On the highways they will be capable of traveling at normal truck speeds.

Because of the lower speed requirements, the in-plant transporters and handling dollies used during the assembly and recycle phases have a much simpler suspension system than the highway equipment.

Part of the test program for this transportation system will include use of some of the equipment in connection with flight tests at Patrick Air Force Base, Fla.

The next major milestone of the Minuteman program was the scheduled initial launching of the missile at Cape Canaveral. Prior to the first flight of the missile, however, much will have been done to test the weapon and its components both separately and together on the ground—or close to it.

For example, the concept of launch directly from an underground launcher was proved in a series of eight tethered launches at Edwards Air Force Base in the Mojave Desert of California. In these tests, dummy missiles with sufficient propellant in the first stage for launch out of the silo were fired.

Each was successful and served to prove that the simple buried silo is practical for launching solid-propellant Minuteman missiles. Success of the eight firings eliminated the need for ten additional test shots which had been planned, saving invaluable development time and about $10 million. During the last half of 1960, testing of the three solid-propellant rocket stages was accelerated at the respective contractor plants.

TRANSFORMING the Minuteman into an operational weapon system requires special attention. In this connection, a three-part program is being undertaken by the Air Force and Boeing at Vandenberg Air Force Base, Calif. After the construction of facilities next year at Vandenberg AFB, the integrating contractor, Boeing, will work with the Air Force in:

1. Conducting the systems engineering test program to demonstrate installation, operation, and maintenance procedures for the weapon system.

2. Training Air Force supervisors and instructors who will train Strategic Air Command crews.

3. Assisting the Strategic Air Command in the initial launchings of both silo and mobile missiles.

As 1961 begins, the Minuteman is entering a new and most important phase of its development—flight test. From this test program will come the engineering and development data and experience leading to the operational deployment of the Minuteman weapon system in mid-1962.

The ENIAC Story

The world's first electronic digital computer was developed by Army Ordnance to compute World War II ballistic firing tables

Martin H. Weik

AS in many other firsts along the road of technological progress, the stimulus which initiated and sustained the effort that produced the ENIAC (electronic numerical integrator and computer)—the world's first electronic digital computer—was provided by the extraordinary demand of war to find the solution to a task of surpassing importance. To understand this achievement, which literally ushered in an entirely new era in this century of startling scientific accomplishments, it is necessary to go back to 1939.

As the year 1939 dawned on an apprehensive and fearful Europe, soon to realize the worst of its fears with the outbreak of the war on September 1st, the United States continued largely oblivious to the outside world and its impending fate. This obliviousness was in no way better exemplified than in the size and state of unreadiness of the U.S. Army.

TWO decades of complete indifference toward military preparedness had witnessed its virtual elimination as a factor of any military consequence in the world. In that fateful year the total strength of the Regular Establishment of the Army was approximately 120,000 officers and men.

The part of this exceedingly small peacetime establishment which provided the principal scientific and logistic support was the Ordnance Department. This Department had the responsibility for the design, development, procurement, storage, and issue of all combat matériel and munitions for the Army. In 1939 it was staffed by a relative handful of officers and career civilian employees.

Mr. Weik is with the Ordnance Ballistic Research Laboratories, Aberdeen Proving Ground, Md. He was assisted in the preparation of this article by Herman H. Goldstine and Paul N. Gillon, both of whom were instrumental in the creation of the ENIAC.

The only scientific facility then available to the Ordnance Department for carrying out experimentation with weapons was the Aberdeen Proving Ground in Maryland. This facility had been acquired at the beginning of World War I and had been heroically maintained during the disheartening interim period so that at the outbreak of World War II it was able single-handedly to perform the crucial task of testing all combat matériel during the critical period of mobilization of the American war effort.

One of the extraordinarily important tasks which devolved upon the proving ground was the preparation of firing and bombing tables for the Army which at that time, of course, included the Army Air Corps. This responsibility was carried out at the Ballistic Research Laboratory of the Ordnance Department at Aberdeen. Here also were obtained experimental data of high accuracy and precision, necessary to the computation of the firing and bombing tables.

What was the situation at the Ballistic Research Laboratory on the eve of World War II? Its computing group comprised just a handful of civilian employees of the Ordnance Department. These individuals were well trained and highly skilled in the conventional methods of computation of firing and bombing tables. Available to this group at that time was one important calculating device other than standard desk calculators—this was the Bush differential analyzer.

This analogue device, or continuous variable calculator, had been installed at the proving ground about five years previously under the direction of Maj. James Guion of the Ordnance Department, then head of the ballistic computations section of the proving ground.

THE analyzer installed at Aberdeen had ten integrating units and provisions for two input and two output tables as well. But, despite its value as an important mechanical aid to computation, it had several severe limitations. Probably the most severe of these was the mechanical torque amplifier. This element of the analyzer sufficiently amplified the extremely small torque developed by the integrating units so as to permit its transmission and utilization elsewhere in the device to drive other elements including other integrators.

This torque amplifier, although simple in mechanical design, frequently failed toward the end of a long trajectory run with the loss of the preceding computation and an appreciable delay associated with its repair.

The officer in charge of ballistic com-

putations at that time was Lieut. P. N. Gillon, Ordnance Department, who had just assumed responsibility for ballistic computations at the outbreak of the war in Europe. His immediate recognition of the immensity of the task that would devolve upon the Ordnance Department in the event of America's involvement in the war prompted him to seek both marked improvement in mechanical aids to computation and augmented facilities for their accomplishment.

IT was, of course, known that the Moore School of Electrical Engineering of the University of Pennsylvania had a Bush differential analyzer of somewhat larger capacity than the one installed at Aberdeen. As a matter of fact, the one at the Moore School had fourteen integrating units. Therefore one of the first steps taken was the award to the University of Pennsylvania of a contract by the Ordnance Department for the utilization of this device.

Following the award of this contract, Lieutenant Gillon in his capacity as officer in charge of ballistic computations conferred frequently with Dean Harold Pender, Professor J. G. Brainerd, and their associates at the Moore School with a view to effecting proper coordination of the computational work at Philadelphia and Aberdeen.

Fortunately, at this time there was a very talented group at the Moore School under the direction of Professor Brainerd and as a result of Lieutenant Gillon's discussions with the professor and his associates, Assistant Professor Weygand undertook to develop an electronic torque amplifer to replace the mechanical torque amplifiers on the Bush differential analyzers. This work was eminently successful and in a rather brief period of time.

In addition, photoelectric followers were developed by the Moore School group for both the input and output tables of the analyzer. As a result of these accomplishments the productive capacity of the analyzers at both the Moore School and at Aberdeen were enhanced by at least an order of magnitude.

During the same period of time the computational activities at Aberdeen were being expanded greatly, and the increase in staff included both military and civilian personnel. Among the former, shortly after America's entry into the war, one of the very important individuals in the ENIAC story came to duty at the proving ground. This was Lieut. Herman H. Goldstine, a Reserve officer of the Ordnance Department.

Lieutenant Goldstine had received his doctorate in mathematics at the University of Chicago under Professor Bliss who had, himself, been one of the principal ballisticians at the proving ground during World War I.

Upon reporting to active duty at the proving ground, Lieutenant Goldstine was assigned to the Ballistics Research Laboratory as an assistant to Captain Gillon. In view of the increased importance of the activities in Philadelphia, which by this time included a training responsibility in the mathematics of ballistic computations, Captain Gillon requested that Lieutenant Goldstine be assigned to duty at the University of Pennsylvania as supervisor of the computational and training activities there.

In September 1942, Colonel Gillon was assigned to the Office of the Chief of Ordnance as deputy chief of the Service Branch of the Technical Division with the responsibility for the research activities of the Department, including those at the respective Ordnance facilities. This, of course, included the work performed in the field of ballistic computations.

This responsibility required frequent contact with the activities at the University of Pennsylvania, and as a result thereof in the early part of 1943 Captain Goldstine and Professor Brainerd brought to Colonel Gillon the outline of the technical concepts underlying the development of the ENIAC. This outline had been prepared at Captain Goldstine's request by Dr. John W. Mauchly and J. P. Eckert, Jr.

COLONEL Gillon fully realized the formidable opposition that probably would be offered to the initiation and prosecution of a development of this sort, especially in view of the highly speculative character of its successful completion. He was convinced, however, of the importance of the need not only to ballistic computations but also to the research activities of the Ordnance Corps as well, and accordingly he undertook to obtain the necessary authorization for its initiation and assumed full responsibility for its support and supervision.

The original agreement between the United States of America and the trustees of the University of Pennsylvania, dated June 5, 1943, called for six months of "research and development of an electronic numerical integrator and computer and delivery of a report thereon." This initial contract committed $61,700 in U. S. Army Ordnance funds.

Nine supplements to this contract extended the work to 1946, increased the amount ultimately to a total of $486,804.22, assigned technical supervision to the Ballistic Research Laboratories, and called for the delivery of a working "pilot model," first to be operable at the University of Pennsylvania and then to be delivered to the Ballistic Research Laboratories at the Aberdeen Proving Ground.

FROM this point forward, the research staff and faculty of the Moore School under Dr. Pender undertook rigorous prosecution of the development pursuant to the terms of the Ordnance contract. The project was placed under the supervision of Professor Brainerd, with Mr. Eckert as chief engineer and Dr. Mauchly, who provided the original outline for this development, as principal consultant. Captain Goldstine, the resident supervisor for the Ordnance Department, not only exercised extraordinarily detailed and highly competent supervision for the Government but also contributed greatly to the mathematical side of this undertaking. As in all important undertakings which achieve important results, this was the work of many individuals.

The ENIAC was placed in operation at the Moore School, component by component, beginning with the cycling unit and an accumulator in June 1944. This was followed in rapid succession by the initiating unit and function tables in September 1945 and the divider and square-root unit in October 1945. Final assembly took place during the fall of 1945.

By today's standards for electronic computers the ENIAC was a grotesque monster. Its thirty separate units, plus power supply and forced-air cooling, weighed over thirty tons. Its 19,000 vacuum tubes, 1,500 relays, and hun-

dreds of thousands of resistors, capacitors, and inductors consumed almost 200 kilowatts of electrical power.

But ENIAC was the prototype from which most other modern computers evolved. It embodied almost all the components and concepts of today's high-speed, electronic digital computers. Its designers conceived what has now become standard circuitry such as the gate (logical "and" element), buffer (logical "or" element) and used a modified Eccles-Jordan flip-flop as a logical, high-speed storage-and-control device. The machine's counters and accumulators, with more sophisticated innovations, were made up of combinations of these basic elements.

ENIAC could discriminate the sign of a number, compare quantities for equality, add, subtract, multiply, divide, and extract square roots. ENIAC stored a maximum of twenty 10-digit decimal numbers. Its accumulators combined the functions of an adding machine and storage unit. No central memory unit existed, *per se*. Storage was localized within the functioning units of the computer.

The primary aim of the designers was to achieve speed by making ENIAC as all-electronic as possible. The only mechanical elements in the final product were actually external to the calculator itself. These were an IBM card reader for input, a card punch for output, and the 1,500 associated relays.

Another design objective was to make the electronics simple and reliable. This goal was achieved by utilizing vacuum tubes in a minimum of basic circuit combinations. To ensure reliable operation, circuits were constructed to rigidly tested standard components which were operated at current, voltage, and power levels below their normal ratings.

Accuracy of computation was assured by designing the basic circuits to work independently of the variable tolerances of their components. Numbers were not represented by electrical quantities which could be affected by changes in tolerance but only by the presence or absence of dynamic pulses.

The gate performed the switching or logical "and" function. It consisted of a single pentode which had a control voltage applied to its suppressor grid. Its function was similar to that of a single pole switch in that it "opened" (passed a pulse pattern) when the suppressor grid was positive and "closed" when the suppressor grid was negative.

The buffer contained two or more tubes connected through a common load resistor to form a circuit with the logical properties of the word "or." The grids of the tubes were normally biased at the cut-off point so that a positive input to any tube in the combination produced a negative output.

The flip-flop circuit contained two triodes so connected that only one would conduct at a given time. The bistable device had two inputs and two outputs. In the set, or normal position, one side of the output was positive, the other negative. In the reset, or abnormal position, these polarities were reversed. Logically, the flip-flop performed the functions of memory and that of a double-pole, double-throw switch. The state of each flip-flop was indicated by a neon lamp on the front panel of the computer units.

A group of ten flip-flops, (0-9), interconnected to count digit pulses, formed a decade ring counter which was capable of adding and storing numbers. The ring counter possessed the following characteristics: (1) At any one time only one flip-flop could be in the reset state; (2) a pulse to the counter input reset the initial flip-flop in the chain; (3) The circuit could be cleared so that a specific flip-flop was in the reset position while the others remained set.

Each flip-flop of a counter was termed a stage, and reception of a pulse at the input side advanced the counter by one stage. Information was recirculated through the counter; *i.e.*, the last stage was coupled to the first. A variation of the basic counter circuit, the PM counter, controlled the sign of a number in the accumulator.

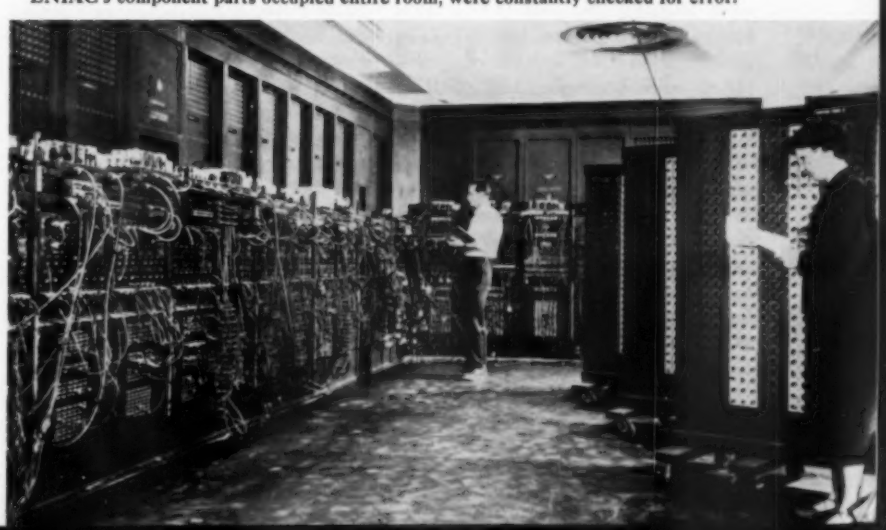
Ten decade ring counters, one per decimal place, plus one PM counter, formed the basic arithmetic and storage unit of ENIAC—the accumulator. The decade ring counters were equipped with ten transmission circuits so that when any ring passed the nine positions, a pulse was passed to the next ring in the series. Input pulses reaching the accumulator added to or subtracted from its contents.

THE accumulator was an essential element in all of ENIAC's arithmetic operations. Addition required two accumulators—one transferring its contents to the other. Subtraction, accomplished by a complement-and-add process, also used two accumulators. In normal multiplication, four accumulators stored the multiplier and multiplicand and accumulated the partial products. In division they shifted the remainder and stored the numerator, denominator, and quotient. The function table utilized the accumulators for storage of the argument and accumulation of the function value.

A synchronous system, ENIAC operated under the control of pulses from a cycling unit. The pulses were emitted at 10-microsecond intervals. The overall timing cycle or repetition rate was 200 microseconds, one addition time. Pulses were transmitted to all units continuously and simultaneously, and each computer operation took an integral number of addition times. For checking and trouble-shooting purposes, the cycling unit circuitry included provisions for operation in a one-addition or one-pulse-at-a-time mode.

The ENIAC was not originally designed as an internally programmed computer. The program was set up

ENIAC's component parts occupied entire room, were constantly checked for error.



manually by varying switches and cable connections. However, means for altering the program and repeating its iterative steps were built into the master programmer. Digit trays, long racks of coaxial cables, carried the data from one functioning unit to another. Program trays, similarly, transferred instructions; *i.e.*, programs. In purely repetitive calculations the basic computing sequence was set by hand. The master programmer automatically controlled repetition and changed the sequence as required.

The master programmer contained ten 6-stage counters—each routing incoming program pulses over a field of six output channels. The position of the counters was controlled by either the number of pulses which had been supplied to the output channels or by the number of pulses received at a special input terminal. In this fashion, the number of sequences could be fixed in advance or made contingent on the results of a computation.

EACH functioning unit of ENIAC was equipped with local program-control circuits. These circuits contained switches which were set for the function required. When the local program circuit was stimulated by a program pulse, the unit performed the desired operation. After it finished, a program-completion pulse was emitted, via the program tray coaxial line, to the next unit in the operational sequence.

In addition to its cycling unit, twenty accumulators, and master programmer, ENIAC included an initiating unit, a high-speed multiplier, a divider, a square-root unit, and three portable function tables.

The initiating unit turned ENIAC on and off, cleared it, and initiated computation.

The high-speed multiplier did its work in much the same fashion as a human would. It contained a built-in multiplication table capable of multiplying up to 9 times 9. Multiplication of the multiplicand by each digit of the multiplier took one addition time. The left- and right-hand figures of each product of a digit of the multiplicand and the multiplier were accumulated separately to form two partial products, which, when combined, formed the final product. The multiplication process for two 10-digit numbers took 2.6 milliseconds.

The divider and square-root unit worked by repeated subtraction and addition, a time-consuming procedure which took an average of 25 milliseconds for a 10-digit number. The divisor was subtracted from the dividend, and the sign of the partial remainder was tested after each step. When the sign became negative, the remainder was shifted up-scale and the divisor was added until the sum became positive. An accumulator serving as a quotient register kept a count of the number of additions and subtractions for the successive decimal places. Extraction of a square root was a similar process.

The principal purpose of the function tables, which actually were banks of switch-controlled resistor matrices, was the storage of the arbitrary functions called for by the problem. The switches selected one of 12 digits and 2 signs for each of the 104 values of an independent variable that were stored in each table. The functional similarity between modern computers and the ENIAC is rather astounding, although the ENIAC was designed almost two decades ago.

The ENIAC was formally dedicated at the Moore School of Electrical Engineering of the University of Pennsylvania on February 15, 1946, and it was accepted by the U. S. Army Ordnance Corps in July, four years after the original suggestion by Dr. Mauchly.

All during 1946 the ENIAC remained at the Moore School, working out numerical solutions to problems in such fields as atomic energy and ballistic trajectories. Dismantling at the Moore School began in the winter, and the first units arrived at Aberdeen Proving Ground in January 1947. The ENIAC became operational again in August 1947.

The ENIAC's first few years at the Aberdeen Proving Ground were difficult ones for the operating and maintenance crews. The computer represented the largest collection of interconnected electronic circuitry then in existence, and its thousands of components had to remain operational simultaneously. The result was a huge preventive-maintenance and testing program, which, in the end, led to some major modifications of the system.

TUBES were life-tested, and statistical data on the failures were compiled. This information led to many improvements in vacuum tubes themselves. Procurement of large quantities of improved, reliable tubes, however, became a difficult problem. Power-line fluctuations and power failures made continuous operation directly off transformer mains an impossibility. The substantial quantity of heat which had to be dissipated into the warm, humid Aberdeen atmosphere created a heat-removal problem of major proportions. Down times were long; error-free running periods were short.

PROGRAMMING new problems meant weeks of checking and set-up time, for the ENIAC was designed as a general-purpose computer with logical changes provided by plug-and-socket connections between accumulators, function tables, and input-output units. However, the ENIAC's primary area of application was ballistics—mainly the differential equations of motion.

In view of this, the ENIAC was converted into an internally stored fixed-program computer when the late Dr. John von Neumann of the Institute for Advanced Study at Princeton suggested that code selection be made by means of switches so that cable connections could remain fixed for most standard trajectory problems. After that, considerable time was saved when problems were changed.

The ENIAC performed arithmetic and transfer operations simultaneously. Concurrent operation caused programming difficulties. A converter code was devised to enable serial operation. Each function table, as a result of these changes, became available for the storage of 600 two-decimal digit instructions.

Those revolutionary modifications, installed early in 1948, converted ENIAC into a serial instruction execution machine with internal parallel transfer of decimal information. The original pluggable connections came to be regarded as permanent wiring by most BRL personnel.

By February 1949, when the ENIAC completed the computation for Project Chore, an Ordnance Corps contract with the University of Chicago, operating difficulties had been reduced to a minimum. Running times were longer, down times shorter and reduced in number. The Chore contract and others completed during this period proved the ENIAC's worth. Other machines, among them the Bush differential analyzer and the Bell relay calculator, would

have required a prohibitive length of time to complete the problems that were assigned to the ENIAC, and the latter was much faster than any digital system then in existence.

For example, a skilled person with a desk calculator could compute a 60-second trajectory in about 20 hours. The analog differential analyzer produced the same result in 15 minutes. ENIAC required 30 seconds—just half the time of the projectile's flight.

The ENIAC led the computer field during the period 1949 through 1952 when it served as the main computation workhorse for the solution of the scientific problems of the Nation. It surpassed all other existing computers put together whenever it came to problems involving a large number of arithmetic operations. It was the major instrument for the computation of all ballistic tables for the U. S. Army and Air Force.

In addition to ballistics, the ENIAC's field of application included weather prediction, atomic-energy calculations, cosmic-ray studies, thermal ignition, random-number studies, wind-tunnel design, and other scientific uses. It is recalled that no electronic computers were being applied to commercial problems until about 1951.

EDVAC and ORDVAC, both faster than ENIAC, began to share the Computing Laboratory's workload with the ENIAC in 1953. It became apparent almost immediately that the ENIAC would have to be modified if it were to remain competitive, economical, and efficient. Modifications, based on new developments in the computer art, were again made on the ENIAC.

In addition to an independent motor-generator set, which eliminated the power troubles, a high-speed electronic shifter, which reduced by 80 per cent the time required for numerical shifting and eliminated numerous tubes and program units, was installed early in 1952. Later, in July 1953, a 100-word static magnetic-core memory was added to the system.

The core storage unit, the first operational unit of its kind, was built by the Burroughs Corporation. The binary coded decimal, excess three, system of number representation was used. It was operated successfully three days after its arrival at BRL and continued in service until the ENIAC was retired.

Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

To provide for the additional memory capacity, the ENIAC was equipped with a new function-table selector, a special memory-address selector, and special pulse-shaping circuits. Three new orders were added to the converter code for use with the new memory.

Despite these modernizations and the fact that trouble-free operating time remained at about 100 hours a week during the last 6 years of the ENIAC's use, its operating costs were far above those of the EDVAC and ORDVAC. The ENIAC was no longer competitive from an economic point of view. The workload gradually was shifted to the other machines, and at 11:45 p.m. on October 2, 1955, the power to ENIAC was removed.

The late Dr. von Neumann suggested that attempts be made to preserve at least some of the ENIAC at the Smithsonian Institution at Washington, D. C. So far, efforts at preservation have had several concrete results. An operational ENIAC accumulator unit has been shipped to the United States Military Academy at West Point, N. Y., for display in the Academy museum. The Smithsonian will display portions of the ENIAC as soon as space becomes available.

The National Science Foundation has several computer exhibits in the United States and Europe, containing portions of the ENIAC. Efforts are being made to have the U. S. Army Office of Military History declare the ENIAC as historical-interest property. It is hoped that this progenitor of a new industry—the key which opened new avenues of approach to solutions of many perplexing scientific problems, the device which pioneered the evolution of high-speed digital computing and automatic data-processing machinery—will be preserved for posterity.

Looking back over the years from 1939 to the fateful evening of October 2, 1955, one can clearly see the life cycle of an enterprise. A need existed for faster computing speeds, and Army Ordnance had made known this need to the Moore School.

Mauchly and Eckert suggested an electronic digital computing design which Gillon believed was worthy of the fullest Ordnance support. Eckert supervised construction. Coders, programmers, and engineers made it run and produced useful results which otherwise would have been unattainable. The rapid progress of computer technology, spurred by the ENIAC itself, soon made the device obsolete.

THUS ended the life of the once glorious pioneer in the field of digital computation. As stated in the June 1958 report of the Operations Research Office of the Johns Hopkins University, entitled "Defense Spending and the U. S. Economy": "The present electronic computer industry is the direct product of Army-sponsored research. . . .", resulting in the ENIAC, "the first modern electronic computer." It's death was a natural one—it had served its purpose.

Small but Reliable

Semiconductor devices not only have replaced the vacuum tube but have resulted in new circuit types utilizing miniature equipment

Dr. Harper Q. North

THE armed services have recognized the importance of the semiconductor device since the announcement of the transistor in 1948 and have supported a great deal of research and development in the field through contracts. In a sense the services have nurtured this infant industry in its formative years and have been responsible in a large part for its dynamic growth.

In fact, to them goes the credit for firmly establishing several of today's principal semiconductor companies, for without Government support they would not have been able to obtain sufficient backing to sustain them through the uncertain years of research and development required to carry high-performance diodes and transistors from their invention through the pilot-production phase.

NOW that the industry has come into its own, large companies frequently can afford to support their own research and development provided they have assurance that the end product is immediately salable; if it is not, Government funding is still required, particularly for new devices where costs of tooling for military production are heavy. The development of complex military systems in large part has assured the salability of products of exceptional performance—performance which was desirable but which could not be afforded in commercial applications.

The major trend today in military systems is toward miniaturization, reliability, and maintainability. In each of these areas the semiconductor device makes important contributions; in fact, systems which were once out of the question from these standpoints now become entirely practical. For this reason, among others, the semiconductor-device industry finds itself not only replacing vacuum tubes but supplying circuits which were not possible prior to the advent of the transistor.

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It is now expected that the foot soldier will be able to transmit and receive commands through electronic gear contained in his helmet just as satellites millions of miles in space can transmit information concerning their surroundings and can receive command signals beamed in their direction from far distant ground stations.

Miniaturization of components and therefore of systems has led simultaneously to the achievement of reliable performance. Usually one must seek such valuable attributes independently over long periods of time and at great expense. Microelectronics has made extreme miniaturization and reliability available together, and we may look forward to the rapid assimilation of these desirable qualities in both military and commercial circuits in the very near future.

However, the ultimate in both, as represented by the solid-state circuit or "molecular circuit," seems to require substantial advances in basic technology before becoming economically available to users in mass quantities. This trend, however, is somewhat more sophisticated than more prosaic trends which are evident in the industry today.

Today's solid-state circuits deserve both honorable and dishonorable mention. They comprise an assembly of devices—diodes, transistors, resistors, and voltage-variable capacitors—all formed within a single block of semiconductor material, preferably silicon (at least for the present).

THERE is no doubt whatever that such circuits will one day be in widespread use. The only question is how soon. In such circuits semiconductor technology is a seriously limiting factor. It is not quite true, but almost, that the yield of good circuits is a product of the yields of the individual components comprising those circuits. If the yield of a sophisticated individual component is, say, 50 per cent, that of circuits with four components is $(.5)^4$, or about 6 per cent.

Some relief is afforded by the fact that individual components of this sophistication are not always required and assemblies of simpler components sometimes can be employed to perform the required circuit functions. However, the economics of producing circuits to the low yields usually experienced limits their applicability to uses where size is of ultimate importance, as perhaps in satellites where the market, to say the least, is rather small.

Sometime ago Pacific Semiconductors, Inc., chose to follow an intermediate path while studying required solid-circuit technology from a more basic point

of view. The company reasoned that it would be better to weld together microcomponents, each of which had been proved through prolonged life tests for thousands of hours than to try to jump immediately into assemblies of such components and fight the yield problem. Following such a procedure, only individual components are used which have been pretested and which are known to be within the required specifications. The result is that the final microminiature circuit can be produced to a very high yield and therefore at considerably less expense than that for the more sophisticated solid-state circuit.

IT is the opinion of many that desire is ahead of technology in solid-state circuits and that technology should be improved considerably before talking about the wild-blue yonder of "molecular circuits" in which current paths are created at will as a block of semiconductor is formed and components have distributed parameters as they are deposited in the semiconductor block, rather than appearing as lumped circuit constants familiar to most designers. It seems that publicity in this area is well ahead of technology. It is a somewhat easier field and much less expensive to pursue!

It is also the opinion of many that the manufacturer of microcomponents and even of standard components has several years to enjoy a market for his products before he is superseded by solid-state circuits, to say nothing of molecular circuits. But solid-state circuits are on their way, and work on them is well advised.

Five years or so from now they will undoubtedly be in mass production. By then they will begin to take over, and when they do, we'll see brand new kinds of computer and redundant components.

In the meantime, it seems advisable to learn control, advance technology, and use a lot of microcomponents, each tested for performance before assembly to avoid devastatingly low circuit yields and correspondingly high costs.

There are, of course, predictions which can be made with respect to less controversial processes and devices. The first regards semiconductor materials. It is becoming evident that silicon will ultimately replace germanium in many semiconductor devices. I predict that ultimately 80 to 90 per cent of all germanium devices will be replaced by those employing silicon as an active element.

The advantages of silicon are predominant over those of germanium in all but a few applications. The higher mobility of germanium is a factor at microwave frequencies, and its lower forward voltage is desirable in applications requiring extremely low resistance switches, but silicon devices should be cheaper in the long run than germanium devices.

This is not likely to be the case until technologies are equally advanced and until automation reduces the labor content appreciably. However, about twenty-seven per cent of the earth's crust is silicon, and the processing of transistor-grade silicon should become less costly as consumption increases. Germanium, on the other hand, is a relatively rare element estimated to be present as only about one part in 10^{13} parts of the earth's crust.

The disappearance of germanium devices is apt to be slow, however, because of the momentum which the material has and the difficulty of replacing devices with those of different characteristics. It seems evident, nevertheless, that silicon will displace germanium in most applications in the years to come.

Intermetallic compounds are currently receiving a lot of attention, but the technology for handling them presents a deterrent even greater than that which silicon experienced during its early years. Today's intermetallic compounds are good enough in purity and perfection for devices which require heavily doped semiconductors and in which crystalline dislocations are not of great importance. The Esaki, or tunnel, diode is an excellent example of a device in which chemical purity and crystal perfection do not seem to be vital factors.

Varactor diodes have been growing in acceptance recently and they seem to be on the way toward eliminating other forms of mixing devices. The requirements for pumping power is a drawback, but it is less objectionable than the low-temperature requirement of most masers. The varactor diode is a versatile device at microwave frequencies ranging in application from mixers and waveguide switches to harmonic generators of millimeter waves.

The Esaki diode is a remarkable device. Its use as an ultrahigh-frequency oscillator of modest power seems assured, and it is being studied in many laboratories as a switching element for computer circuits. Computer designers are having to revise their thinking because of this device which operates at low voltages and which, unlike the vacuum tube or transistor, does not have isolated input and output circuits and appears similar from either direction.

Transistors are now operating successfully in the microwave region, as well as at very high power levels at several megacycles. Reported operation of germanium transistors at 2,500 or 3,000 megacycles seems to be a practical limit for the moment because of the extremes of geometry which are required in their construction. Emitter and base stripes are a mil or so by two- or three-tenths of a mil, and the attachment of leads becomes a formidable problem.

POWER transistors have delivered 100 watts at 10 megacycles or more, and 1,500-watt units have been constructed without appreciable degradation in frequency response. These units undoubtedly can go into the 5-kilowatt range without serious frequency degradation if we can learn to use extremely low impedance devices.

However, there is another limitation which stems from semiconductor technology limits: The same phenomena that reduce yield in small units appear in spades when a bad spot on a one-inch-square transistor surface completely destroys device performance. But the high-power transistor seems to be here to stay.

The semiconductor field is advancing with amazing rapidity, and there are now enough contributors in enough different laboratories to make it dangerous to attempt to predict the future with any certainty. Nevertheless, I believe microcomponents will be with us for some time to come and that much can be done to employ them while the technologies applicable to the solid-state or molecular circuits are advanced and made economically practical.

"Microelectronics has made extreme miniaturization and reliability available together and we may look forward to the rapid assimilation of these desirable qualities in both military and commercial circuits in the very near future."

Materials in Space

The Ranger vehicle which is being readied to land an instrument package on the moon will subject metals and compounds to a new kind of environment in which performance can only be estimated

Ralph A. Happe

THE Age of Space upon which we are now entering already has placed unprecedented demands on the materials needed in our spacecraft and satellites, and greater demands will be made as we probe farther and farther into the unknown.

A case in point is the Ranger spacecraft which is being designed to land an instrument package on the surface of the moon—a new and strange environment in which metals and compounds will be required to fulfill tasks they have never been called upon to perform. It is this effect of space on materials that we will consider here.

Environmental factors in space can be listed as pressure, temperature, electromagnetic radiation (or solar radiation), solid particles such as meteoroids and micrometeorites, neutral gas (hydrogen), ions, and electrons. As far as pressure is concerned, outer space is a pretty hard vacuum in comparison with what we are able to produce on our equipment. Note that we are talking about vacuums on the order of 10^{-11} to 10^{-14} millimeters of mercury. The lowest pressures that we have been able to achieve artificially in vacuum equipment are on the order of 10^{-9} or 10^{-10}.

IN considering temperature, it is well to keep in mind that, because of the very low pressure, we are *not* talking about aerodynamic heating. Temperatures are defined by the operating limits of the scientific and telemetering equipment. Control is accomplished by providing conducting paths to the outer skin and emitting or absorbing energy by the use of suitable surfaces.

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In the case of the Ranger space vehicle, the target control temperature is 35 degrees centigrade plus or minus 15 degrees centigrade for the telemetering electronics gear. Maximum excursions of plus or minus 100 degrees centigrade are permitted in certain noncritical portions of the vehicle.

As for electromagnetic radiation, the solar constant in the earth's orbit is 2.0 calories per square centimeter per minute. This we know quite accurately. Ninety-three per cent of solar radiation falls between 0.3 and 2 microns. The former wave length corresponds roughly with the lower limit of the ultraviolet end of the spectrum, and 2 microns is fairly well into the infrared spectrum.

As for solid particles, neutral gas, ions, and electrons, suffice it to say for the moment that we know far less about these than we do about the other factors and also that the indications are that problems concerning these will not be particularly serious, at least so far as instrumented payloads to the moon are concerned.

The weird-looking vehicle shown on the opposite page is a Ranger spacecraft. The first two flights will be launched into highly elliptical orbits to obtain data and to prove out the overall systems.

Materials used are as follows: The upper antenna is made of aluminum alloy joined by dip-brazing to provide good electrical continuity. The upper structure is fabricated from aluminum alloy tubing. The hexagonal frame contains a combination of magnesium alloy castings and aluminum alloy tubing. The hexagonal boxes themselves are made from cast aluminum alloy.

THE directional antenna, which you see shown in its swung-out position, consists essentially of an aluminum-alloy frame and aluminum-alloy wire mesh. The antenna feed is fabricated entirely of stainless steel joined by furnace brazing, induction brazing, and soft soldering. The entire feed is gold-plated to provide radio-frequency conduction. Solar panels are mounted on an aluminum-alloy honeycomb structure bonded together with epoxy adhesive. This is backed up by a riveted aluminum frame.

Inside the hexagonal boxes is a lot of electronic gear. In this particular design the chassis are cast aluminum; other designs may call for cast magnesium. I will explain later why different materials are used for different missions. Along with these chassis, of course, many other materials are used in the electronic gadgetry, such as sili-

con and germanium semiconductors, carbon resistors, plastics, copper wire, solder, as well as a lot of other things that are nonstructural. We will not discuss at this time the materials used in the individual scientific experiments—the rubidium vapor magnetometer, the electrostatic analyzer, the Lyman-alpha telescope, the ion chamber, the micrometeorite detector, and the friction experiment.

One item of interest that isn't shown is the pressure vessel that holds the nitrogen for the attitude-control jets. This is fabricated from pressure-welded titanium alloy (Ti-6Al-4V) in the stabilize-annealed condition.

LET us now consider the effects of the space environment on inorganic compounds.

No particular problems are foreseen in the use of the more chemically stable oxides and other compounds, such as those of titanium, aluminum, magnesium, chromium, thorium, beryllium, silicon, and zirconium. These materials are quite stable, and no special difficulties are anticipated under the vacuum conditions of outer space. For this reason, greater usage of ceramics over plastics for insulators is indicated for future, long-lived missions.

About the less chemically stable oxides and other compounds, such as those of lead, copper, nickel, cobalt, iron, and molybdenum, less is known. We are doing some thermodynamic calculations on some of these compounds at the Jet Propulsion Laboratory, but the results are not in yet.

As for metals, we feel that we have a pretty good understanding of what will happen to them under space conditions. Behavior of pure metals can be predicted with reasonable certainty by use of the Langmuir equation. This equation seems to be quite good for computing evaporation under high-vacuum conditions where mean free paths are long, so that there are essentially no atomic collisions.

The Langmuir equation is expressed in two different forms. The pressure is equal to a constant times the rate of evaporation in gm./cm.^{2}-sec. times the square root of the temperature in degrees Kelvin divided by the molecular weight. It is important to remember, then, that for pressures lower than about 10^{-7} millimeters the evaporation rate for a given metal is a function of temperature only. Environmental pressure has nothing to do with it.

The equation can be rearranged to show the rate of evaporation in centimeters per year. This is a convenient form for calculating what might happen to metals.

The evaporation loss from the surface in centimeters can be plotted against the time in years on a logarithmic scale. The horizontal lines will correspond to one atom layer, one ten-thousandth of an inch, and one one-hundredth of an inch. Magnesium will lose one atom layer in about three years at 50 degrees centigrade. This is the temperature with which we are concerned in the Ranger. Obviously, for structural purposes, we are not particularly concerned with this for missions planned for the near future.

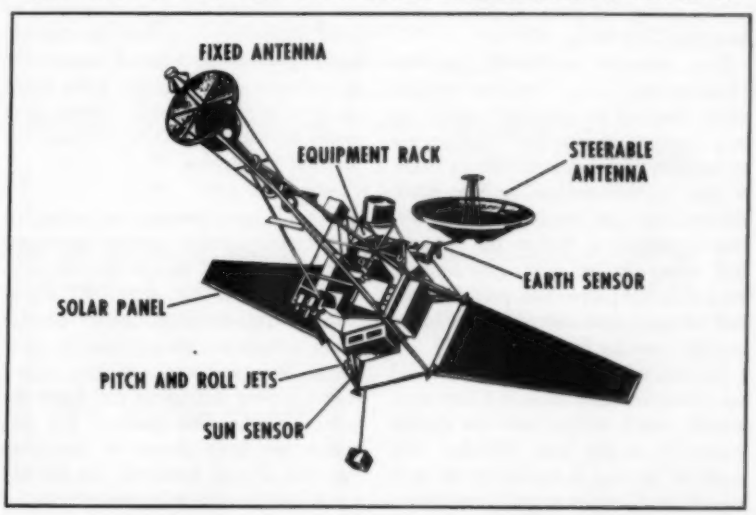
Such information, however, does point up what we consider a problem. If we consider chassis, which I mentioned earlier, the evaporation of material from the chassis and subsequent deposition in other cooler areas resulting in shorting out of electronic circuits might pose a very real problem. Magnesium at 50 degrees centigrade would lose, and presumably redeposit on an equivalent cooler area, one atom layer in about three years. We can assume that one atom layer would be required to conduct electricity if deposition is uniform. Some of the chassis are likely to run hotter than this because of the electronic gear associated with them. Therefore, if we consider a higher temperature, say 135 degrees centigrade, one atom layer would be deposited in a matter of a few days.

These conclusions depend, of course, on the assumption that the layer is deposited in a uniform manner. However, there is a possibility that it may be deposited as whiskers, in which case shorting may occur in times other than those which we can predict in this way. Suffice it to say that we consider this a real problem, and have taken steps to deal with it.

This is why in some Ranger designs which have relatively long lives we have used aluminum chassis. In other designs which will be in space for short periods (less than two weeks), we have used magnesium castings in order to conserve weight. They are dimensionally identical with the aluminum castings, using the same patterns.

FUTURE missions undoubtedly will require the lowest weight that can be achieved practically. Therefore we are also looking at barrier coatings, such as electroplates, for inhibiting the sublimation of magnesium. Tin is quite stable and would take far longer than a hundred years to sublime and redeposit one atom layer. Therefore, tin might be an excellent coating. Cadmium and zinc, which are often used as coatings, would volatilize more rapidly than does magnesium.

Spacecraft for the Ranger and Mariner series, showing components (NASA photo).



If we arrange the metallic elements in order of decreasing vapor pressure it will be seen that aluminum and tin are quite stable; so, we can say that anything near these, or below these, is going to be stable. This includes such elements as lead, silver, copper, gold, and chromium. Thus it is obvious from the standpoint of placing barriers on magnesium that there are a number of choices which should work well.

SO far we have discussed pure metals. While we know less about alloys, I think it is safe to say that the situation is not of particular concern. For instance, a 70/30 brass contains 30 per cent zinc, which is quite volatile. Sublimation should not be so bad as with pure zinc, since there is considerably less of it present. In addition, zinc atoms must first be brought to the surface before they are in a position to fly off into outer space. Therefore diffusion probably becomes the controlling phenomenon here. Fortunately, most alloys, which are substitutional types, have very low diffusion rates at the relatively low temperatures we are discussing.

Considerably less is known about the behavior of organic polymers. I think we can say categorically that most plastics pose problems, and, in my opinion, we will have to be very careful in our use of plastics for long-life missions.

One point to remember about plastics, however, is that they really don't have vapor pressure in the same sense that metals do. Degradation is thought to be a process of portions of molecules detaching and flying off.

Data obtained by the Wright Air Development Center included weight losses obtained on some polymer films in a vacuum of 2×10^{-8} millimeters of mercury after exposure for 24 hours at 300 degrees centigrade. The Kel-f, silicone, cellulose acetate butyrate, styrene butadiene, as well as the phenolic and epoxy looked best according to these data, but polysulfide, polyurethane, and nitrocellulose certainly should be avoided even for brief usage.

Unfortunately, the investigators did not obtain the data in such a way as to provide much insight into the mechanisms of weight loss. We feel that much of the loss is caused by the boiling off of plasticizers and low-molecular-weight fractions. If such is the case, serious dimensional changes, and in some cases embrittlement, might occur. It is not difficult to visualize a poorly chosen potting compound shrinking and tearing wires loose.

"Environmental factors in space can be listed as pressure, temperature, electromagnetic radiation (or solar radiation), solid particles such as meteoroids and micrometeorites, neutral gas (hydrogen), ions, and electrons. As far as pressure is concerned, outer space is a pretty hard vacuum in comparison with what we are able to produce on our equipment. Note that we are talking about vacuums on the order of 10^{-11} to 10^{-14} millimeters of mercury."

Plastics in general are probably more susceptible to radiation damage than are inorganics. We are not particularly concerned about this at present, since our planned missions are all well beyond the Van Allen belts.

Another thing we must consider about plastics is the change that can occur as a result of ultraviolet radiation. We will have much more ultraviolet hitting our thermal control surfaces than would be the case on earth. Because of this we are somewhat concerned about solar-reflecting paints where we want as high a reflectivity as possible. Ultraviolet is well known to cause yellowing of paints, so that reflectivity would be lowered under service in space. Considerably more work needs to be done on this subject, since paints are extremely attractive from the practical standpoint.

I would like to mention one rather important, practical problem concerned with plastics, and that is that the plastics industry is not very well standardized. As a result, every plastics manufacturer has his own favorite plasticizer, dyes, and other additives, which makes it very difficult to pin down the content of the final product. For this reason we have chosen to formulate our own silicone paints so that we will know exactly what is in them.

The whole area of plastics is certainly one in which a lot more information is needed than we now have.

You may have gathered from the foregoing that we really know very little about the subject of material behavior in space. Most of our conclusions are based on theoretical considerations. Such conclusions are no better than the assumptions that must be made in arriving at them, and some really good development and evaluation work must be done in the following areas if we are to gain confidence that our missions will have a good chance of performing as planned: (1) polymers, (2) thermal control surfaces, and (3) bearings and lubrication.

In these areas, present theories are entirely inadequate to predict behavior. Metals and compounds require further work also to verify the theories and assumptions we have made about them. However, I would place them on a lower priority basis than the other three areas. A certain amount of work on metal surfaces and degradation of compounds, such as molybdenum and tungsten disulfide is, of course, indicated in the second and third categories.

Both laboratory experimental work and controlled flying experiments are indicated. The latter, because of expense and limited space availability on the vehicles, should be performed after conducting tests in the laboratory.

A WORD about an alternate route—that is, trial and error—is in order. Remember that these instrumented payloads are, by and large, sent out into space, never to return to earth. In most cases it will be very difficult, or impossible, to correlate materials failures with mission failures with a satisfactory degree of certainty. Manned payloads will be little better than instrumented payloads in this respect. Materials failures often will result in an inability to return to earth. In this case also, obviously very little will be learned about failure causes.

Further information on this subject can be found in technical release No. 34-143 from the Jet Propulsion Laboratory of the California Institute of Technology, under contract to NASA.—THE EDITORS.

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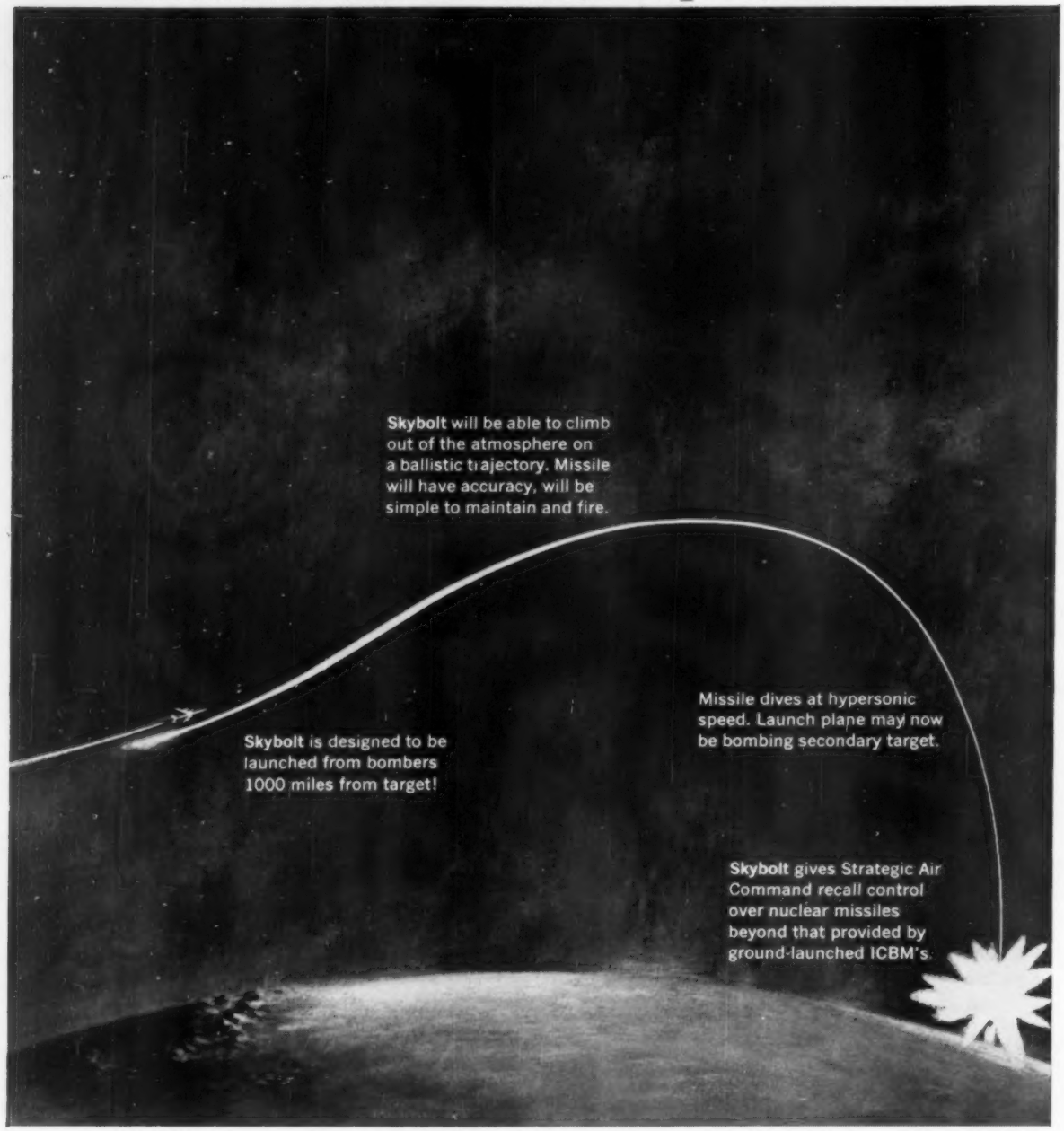
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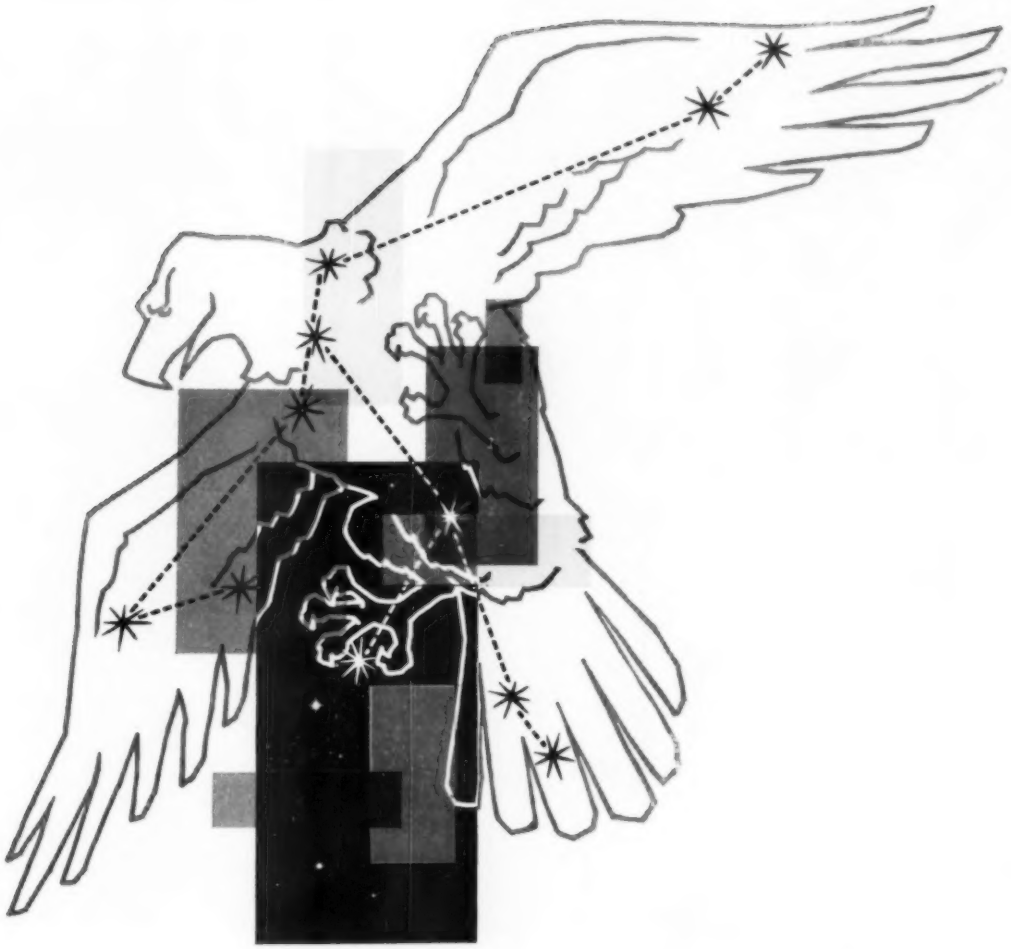

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